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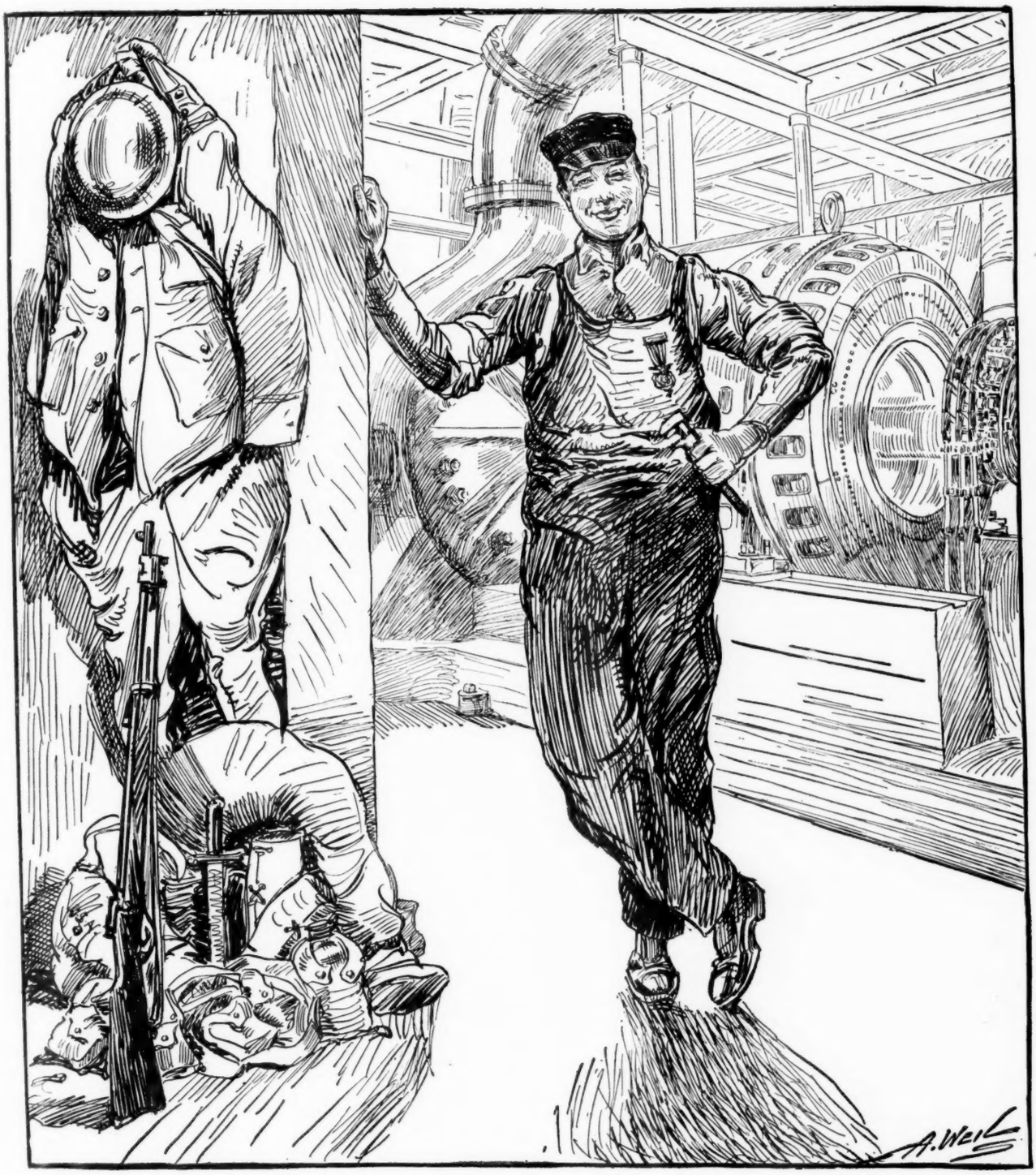

Back on the Job

Keeping Up Condenser Performance*

By HARTLEY LEH. SMITH

The power station engineer is told how he can determine the economy which he should get from his plant, then how he can correct causes of low vacuum.

THE establishment of the relationship that exists between the highest practically obtainable turbine economy, or power plant over-all economy, and the vacuum in the top of a condenser and at the turbine exhaust nozzle, may be gotten in one way or another, dependent upon test facilities and circumstances, but that relationship which is within the reach of all is to determine the highest vacuum actually attained in terms of intake circulating-water temperature. This only requires records of observations kept over a considerable period of time, and naturally the longer the better. All sorts of variable factors conspire to make most observations noticeably less excellent than the best actually attainable, so that in the direction of *poor* results the figures scatter in a haphazard manner when plotted, but in the direction of *best* resu'ts they mark out a boundary line that is both smooth in shape and rational in form.

Such a plot is shown in Fig. 1, extending over a period of only about six months and taken in a typical turbine power plant. It not only covers data from nine different turbine-condenser units, but these units happen to be divisible in the matter of design into groups of three distinct types. All three types are represented at or very near the boundary line. It is significant that a plot of the sort shown in Fig. 1 proves that vacuum maintenance at the top of a surface condenser becomes handicapped by the rise of circulating-water entrance temperature which takes place during the summer. This is due not merely to the direct effect of the rising temperature, but to secondary effects as well, which are somewhat involved but are undoubtedly connected with the rising height of the air cloud, caused by the decreasing efficiency of air removal by the pump equipment during hot weather. To state the over-all effect briefly, it may be said that any plot of the kind shown in Fig. 1 will reveal greater temperature difference between the steam temperature at the top of the condenser corresponding to saturation pressure and the entering temperature of circulating water during summer than during winter.

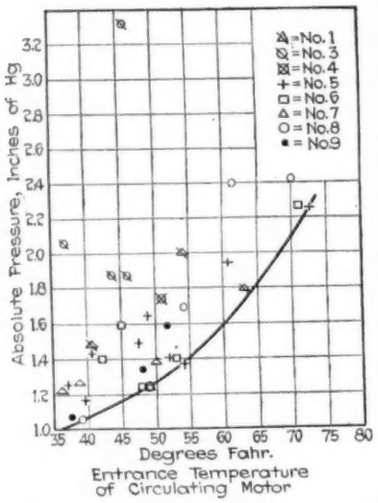

FIG. 1. VACUUM OBTAINED IN TERMS OF INTAKE CIRCULATING WATER TEMPERATURE

The curve of highest possible plant economy is obtained from the best of these readings.

After the establishment of such a standard it ought to be possible to make a strong drive after good condenser vacuum maintenance, because the operator can tell just how far he can go in condemning the indifferent performances shown by observation, regardless of the season of the year. This should make possible the drawing up in the course of perhaps another year of a new standard plot which would not only better the old one with respect to the boundary line of best performance, but would be characterized also by less profuse scattering upward into the region of poor and even very poor performance. Such improvement in the standards of performance could hardly be expected to be continuous from year to year, but it ought to be the result of this sort of intensive and scientific analysis of vacuum maintenance that the first standard established even by accumulations of very considerable data would fall short of what might in time come to be regarded as the ultimate standard.

T. D. CO., TESTING BUREAU

Vacuum Maintenance and Calibration of Condenser Vacuum Gages

Sheet No. 1. T. B. Order..... Williamsburg Power Station

Date	Condenser No.	Found Reading Inches of Hg. Stand. Hg. Column	Found Reading Inches of Hg. Cond. Hg. Column	Left Reading Inches of Hg. Stand. Hg. Column	Left Reading Inches of Hg. Cond. Hg. Column	Barometer	Load Kw.	Temp. of Cir. Water° F. Intake	Temp. of Cir. Water° F. Discharge	R.P.M. of Pumps Air	R.P.M. of Pumps Cir. Water
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	Bristol					
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CONDENSER PERFORMANCE DATA

Condenser Number,

Absolute Pressure, Inches of Hg.,

Speed of Air Pump, R.P.M.,

Speed of Circulating Water Pump, R.P.M.,

Circulating Water Discharge Temperature,

Temperature Rise of Circulating Water { Upper Sect. / Middle Sect. / Lower Sect. }

Load, k.w.,

Pressure on South Gland, Lb. per Sq.In.,

Condenser Hours since Last Cleaning,

Millions of Pounds of Circulating Water per Hour,

Diff. Pressure across Condnsr. (Ref. to Rated Water),

Water Level Intake,

Lost Head with Rated Qnty. of Circulating Water, Ft.,

Excess Temperature of Steam over Discharge Water,

Air Pressure in Air Suction Line,

Absolute Pressure in Clsd. Suction Line of Air Pump,

FIG. 2. FORM FOR TABULATING DETAILED CONDENSER PERFORMANCE

While it would unquestionably be desirable to make a careful analysis of the vacuum maintained by each

*From "Electric Railway Journal."

condenser every day, yet in a plant with numerous turbines it becomes a matter for decision as to whether brief observations should be made on all machines operating or whether much more extended observations should be made on two or three machines so that really detailed diagnosis of their ailments may be followed by equally detailed recommendations of the particular kinds of maintenance work necessary. The writer is inclined toward the latter view. Whatever the nature of one's inclinations, however, it comes back to the fact that detailed recommendations cannot be made unless they rest upon adequately detailed observations and analysis of observations.

Reasons for Form Suggested for Tabulating Condenser Data

An illustration of a form for observations of the detailed type is shown in Fig 2. This form grew out of a form which merely provided for checking up condenser mercury columns, and bears distinct traces of its lineage. The items under "Condenser Performance Data," however, cover in a pretty thorough manner the kinds of data which not only suffice but are required for detailed diagnosis. The order of arrangement of the items may possibly be open to some criticism. In a general way, however, those items are listed first which are matters of direct observation, and they are followed by items which involve some calculation or which are of perhaps secondary importance, and the last item is one which, although of great importance, is quite special in the sense that it could not possibly be obtained simultaneously with the others.

The circulating-water discharge temperature is put high upon the list because, while it is the circulating-

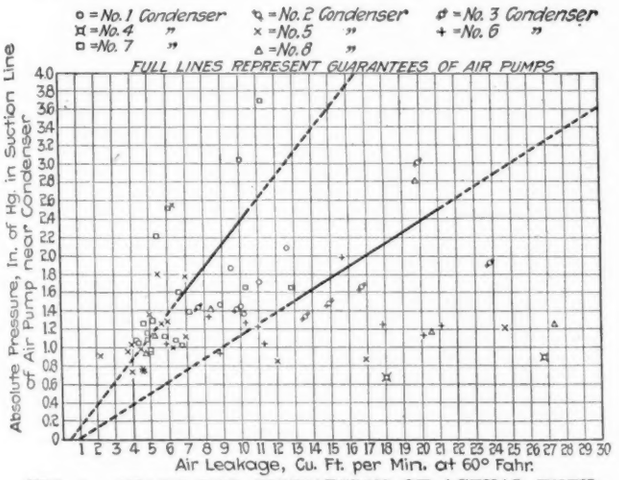

o = No. 1 Condenser
= No. 2 Condenser
= No. 3 Condenser
= No. 4 "
× = No. 5 "
+ = No. 6 "
= No. 7 "
= No. 8 "
FULL LINES REPRESENT GUARANTEES OF AIR PUMPS
Absolute Pressure, In. of Hg. in Suction Line of Air Pump near Condenser
Air Leakage, Cu. Ft. per Min. at 60° Fahr.

FIG. 3. CHART FOR COMPARISON OF ACTUAL WITH GUARANTEED AIR LEAKAGE

water intake temperature and the quantity of water circulating and the turbine load which establish the circulating-water discharge temperature, it is this latter temperature which establishes directly, but in a complex manner, the steam temperature at the top of the condenser and therefore the vacuum in the turbine exhaust nozzle, and therefore the economy of the turbine under consideration.

Next come data of the rises of temperature through the several passes of the condenser, be they two or three. These data are of very great importance because it is a common thing for a most unseemly great proportion of the total rise to occur in the upper pass. This means congestion of heat absorption in the upper pass with consequent undue excess of entering steam temperature above the discharge water temperature, and meanwhile the large investment representing the lower part of the condenser is not earning adequate money. Great preponderance of heat absorption in the upper pass is sure evidence of improperly proportioned steam passageways through the condenser, or the presence of a cloud of air which has risen to rather high

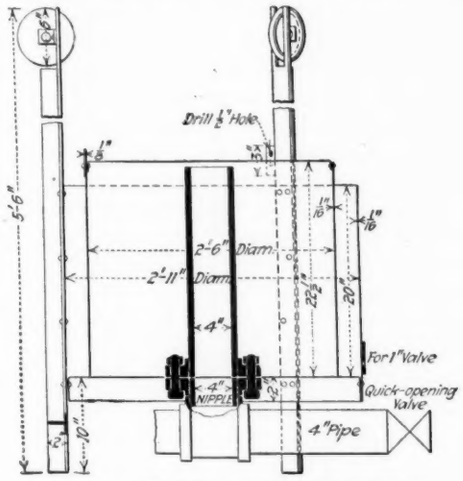


FIG. 4. AIR BELL FOR MEASURING AIR LEAKAGE

level in the condenser. This latter, if it exists, is due to large air leakage into the condenser or poor efficiency of air removal, or both.

It is the business of the diagnostician to clear up contingent possibilities and become specific. If a condenser has improperly proportioned steam passageways, presumably the diagnostician knows it by general acquaintance with steam condenser technical literature of recent years, and calls it to the attention of those in authority who do not know it, if there are any such, and plans are made to provide more adequate steam spaces by permanently removing tubes. If large air leakage into the condenser exists, quantitative measurement of the leakage with an air bell will reveal it. Rotary pumps of the jet type, as distinguished from reciprocating dry-vacuum pumps, do not admit of the use of an air bell. Very good work in such circumstances can be done by applying Dalton's law to simultaneous observations of temperature and pressure in the air suction line. Provision for the result of such measurements is made on the column next to the last of the illustrated form, Fig. 2. It should be noted that if measurements in the air suction line are made with the purpose of applying Dalton's law, refinement of measurement should be attempted because rotary pumps of the jet type frequently have quite large displacement, with the result that if small or moderate quantities of air are leaking into a condenser the air in the act of withdrawal may be diffused through such a very great volume of very low pressure steam as to make the detection of the presence of the air, and much more its quantitative measurement, a matter of difficulty. There is the consolation, however, that if air is being withdrawn in large quantity the detection of its presence

in the air suction line will not be difficult. It should be remarked also that the Dalton law method of quantitative measurement of air removal from a condenser is just as applicable to dry-vacuum pump installations as to the others, subject only to the difficulties incurred in pressure measurements in pipe lines supplying any sort of reciprocating pumps.

Other Possible Faults to Which the Form Calls Attention

It may suffice to take up somewhat briefly a number of the remaining items of importance appearing in the form shown in Fig. 2. Where water-sealed glands serve to prevent air from entering the turbine the pressure of water maintained on the gland supply lines by normal pumping action indicates normal or abnormal functioning of the glands with respect to water consumption. If, for instance, the water consumption becomes abnormally large, the water pressure will fall and the air-sealing efficacy of the gland will be interfered with, with consequent high air leakage and low condenser vacuum.

The hours that a condenser has run since its last cleaning may affect the vacuum in two ways—it may account for a falling away from the normal quantity of circulating water by reason of trash accumulations actually obstructing the flow, and it may interfere with the transmission of heat through the tubes to the water by reason of the heat insulating effects of mud or sediment in the tubes. The hydraulic circuit of the condenser is capable of being handled much like an electric circuit. The differential pressure across a condenser varies greatly with the quantity of water flowing through it, but it also varies considerably at constant water flow with different amounts of trash obstructing it, particularly if the obstructing material is to a considerable extent leaves which become plastered over the tube plate.

Importance of Maintaining Absolute Pressure

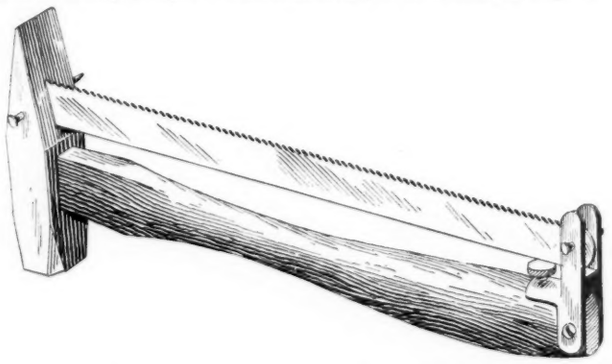
Again, where open intake wells are used, the fluctuation of levels in them may depend upon more than mere tide level variation. Measureable lost head may occur in them due to perforated openings designed to stop obstructing materials which might be harmful to the circulating pumps. Variation of quantity of water circulated due to any cause will then cause variation of this lost head, but if at some constant quantity of circulating water the lost head in the circulating pump suction line increases to values appreciably above normal the bottom of the open intake well may need cleaning out. The absolute pressure which an air pump can maintain against a closed suction valve has been discussed before. Nothing is more important in vacuum maintenance. It is the prime indication of the pumping ability of the pump. To show forcibly how even the degree of air leakage itself is not more important and may in some installations be distinctly less important than the air-tightness and general perfection of mechanical working of parts, Fig. 3 is published, showing absolute pressure in the suction lines of various pumps in actual service with large variations of air leakage coming through the air suction lines from the condensers. The quantities of air leakage were measured by an air bell. The solid portions of the ruled straight lines were drawn through actual guarantees of the performance of a certain type of rotary pump in which water-jet action extracts the air, the upper line representing one pump and the lower line two. The numerous plotted points all represent actual service performance of reciprocating dry-vacuum pumps. The lesson from the plot is clear. If a reciprocating pump is in fine condition it may be capable of removing a great amount of air from a condenser and yet maintain admirably low absolute air pressure while it is doing so. On the other hand, through neglect of skillful maintenance work the absolute pressure may not be notably low even though the air leaking into the condenser and needing to be removed by the pump may be moderate in amount, thanks to a tight condenser.

The use of an air bell gives such powerful means of control of vacuum maintenance by putting air-leakage measurement upon a quantitative basis that an illustration of such a bell may be of interest, and is accordingly shown in Fig. 4. An air bell made from this drawing has been in satisfactory service for several years. The conception of using such a bell for the purpose did not originate with the company with which the writer is connected. So far as he knows it was first used by the New York Edison Company.

As a refinement in the use of an air bell, a hole may be drilled in the top of it and a rubber stopper inserted through which is passed an ordinary chemical thermometer. In this way the temperature of the air may be measured as the bell rises. This allows correction of the air volume to standard temperature to be made.

Useful Combination Tool

An ingenious combination of a hacksaw and a cross-peen hammer is shown in the illustration. This combination, says *Coal Age*, is not only advisable for the sake of convenience, but also to relieve the tool bag of unnecessary weight. Furthermore, it will conserve space.



COMBINATION HACKSAW AND HAMMER

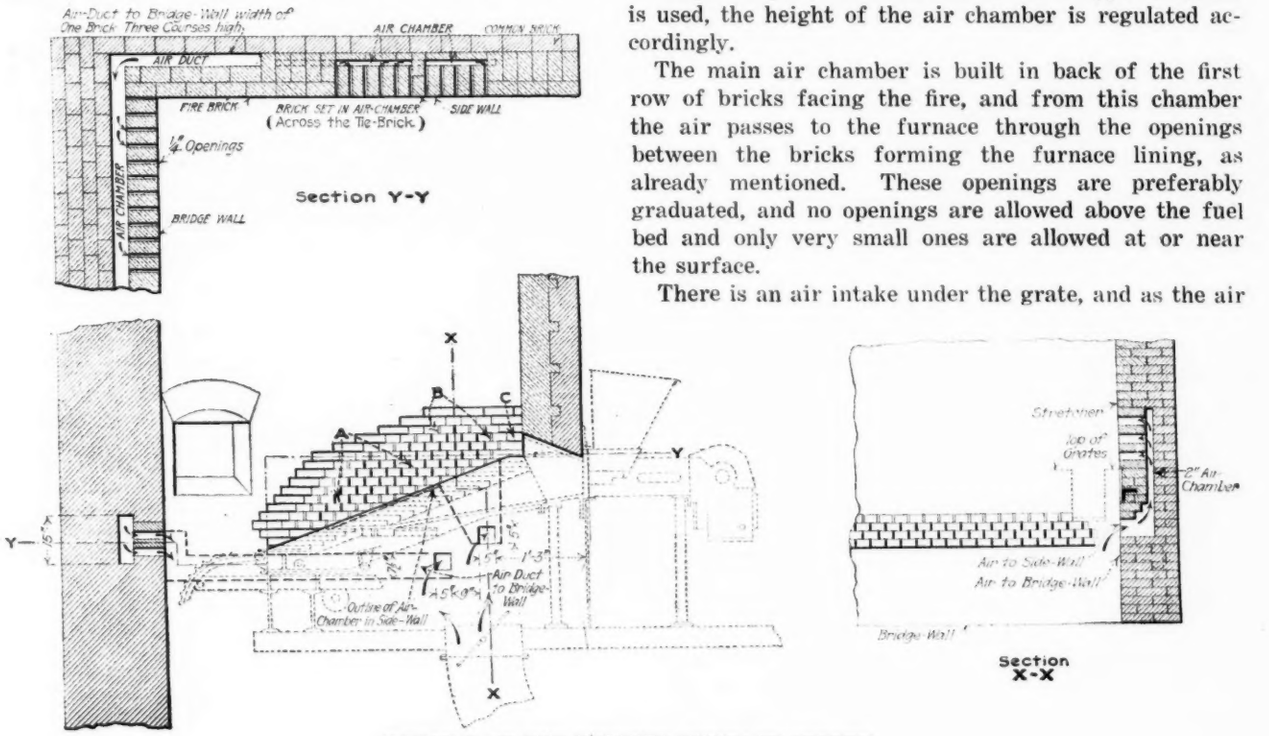
In construction the device is simple, and the illustration is self-explanatory. The hacksaw blade is adjusted by means of the setscrew, which will move the arm toward the right and in this manner tighten the blade.

Various Provinces of the Dominion of Canada are "speeding up" construction and, where needed, legislation to permit the use of much of the available water power as a National asset. The United States should not delay similar action. Water is passing the mill without turning the wheel.

Bernitz Furnace Construction

The proper combustion of coal is not an altogether simple matter, as the ashes naturally slag into clinker, especially where an intense fire is maintained. Clinkers readily adhere to the side of the furnace walls, fuse with the brick and build out into masses, thus preventing a free combustion of the coal adjacent to such clinkers. The clinker mass also extends onto and against the grate and diminishes the capacity of the fuel bed. The labor of removing such clinkers is distasteful to most boiler-room operators.

To prevent the formation of clinkers on the side and bridge-walls of boiler furnaces the Bernitz method has been devised by the Bernitz Method Co., Tremont Building, Boston, Mass. It consists of an arrangement of firebrick in the furnace walls whereby air is admitted into the fuel bed between the bricks of the side setting or at the bridge-wall. By supplying forced draft through these air passes, the face of the brick in the furnace wall is kept comparatively cool, the idea being that the clinker will not then adhere to the brick surface. The combustion at these points is stimulated and increased.



DETAILS OF THE BERNITZ FURNACE SYSTEM

Where forced draft is applied to the fires, a branch conduit is connected to the air passage back of the side walls and the same forced draft is applied through the brick spaces in the side wall.

The circulation of air passing directly into the fire from the furnace walls supplies draft at a point where it seems to be needed. A damper or valve operated from the outside controls the amount of air thus supplied. No more forced draft is used than that supplied to the fire through the grate. The illustration shows the method of constructing the openings between the brick in the furnace walls and also the position of the air boxes.

In the construction of this furnace, all bricks are laid in front of the air chamber facing the fire as headers, and they are so spaced as to provide openings of the required size between the bricks. In the illustration the heavy lines *A* indicate ¼-in. openings between the bricks, the two light lines *B* indicate ⅛-in. openings, and the light line *C*, $\frac{1}{16}$-in. opening. When placing the brick, gages of the proper thickness are used, thus giving the correct spacing throughout the setting; this also prevents fireclay from clogging the opening. The sides of the bricks forming the air space are kept clean of fireclay and the openings are staggered, as shown.

In constructing the air chamber, bricks are set in across here and there to stiffen the structure, but provision is made for the free circulation of air around them. As the depth of the fuel bed is not the same in all power plants even where the same type of stoker is used, the height of the air chamber is regulated accordingly.

The main air chamber is built in back of the first row of bricks facing the fire, and from this chamber the air passes to the furnace through the openings between the bricks forming the furnace lining, as already mentioned. These openings are preferably graduated, and no openings are allowed above the fuel bed and only very small ones are allowed at or near the surface.

There is an air intake under the grate, and as the air is forced into the chamber it escapes to the fuel bed through the openings between the bricks. Circulation is thus set up, and in passing through the chamber and between the bricks facing the fire, a considerable quantity of heat is collected from them, thus cooling them, the object being to prevent them from becoming soft and wasting away.

A damper for controlling the air is usually installed at the intake to the chamber, whereby the intensity of the flow of air through the openings is regulated to meet the average operating conditions of the fire.

On the bridge-wall openings are made between the brick on the first three or four courses from the dump grate up. The air passes through either a separate inlet under the grates and a duct laid in the side wall leading to the bridge-wall, or from an air-supply pipe connecting to the bridge-wall from the main air duct. In either case a damper is installed and is operated by the fireman.

Inspection of Electric Welds

By O. H. ESCHHOLZ
Research Engineer, Westinghouse Electric and Manufacturing Company

Lack of a satisfactory method for this operation has been responsible in very large measure for the hesitancy shown in adopting metallic-electrode arc welding. The author describes various tests and their efficiencies.

DETERMINING the character of welded joints is of prime importance, and the lack of a satisfactory method, more than any other factor, has been responsible for the hesitancy encountered among the engineering profession toward the extensive adoption of electric welding. To overcome this prejudiced attitude the rapidly accumulating knowledge must be shaped into an acceptable method of inspection.

The four factors that determine the physical characteristics of the metallic-electrode arc welds are fusion, slag content, porosity and crystal structure. Some of the important methods that have been suggested and used for indicating these characteristics are as follows:

1. Examination of the weld by visual means to determine: (a) Finish of the surface as an index to workmanship; (b) length of deposits, which indicates the frequency of breaking arc, and therefore the ability to control the arc; (c) uniformity of the deposits, as an indication of the faithfulness with which the filler metal is placed in position; (d) fusion of deposited metal to bottom of weld scarf as shown by appearance of under side of welded joint; (e) predominance of surface porosity and slag.

2. The edges of the deposited layers may be chipped with a cold chisel or calking tool to determine the relative adhesion of deposit.

3. Penetration tests to indicate the linked unfused zones, slag pockets and porosity, by: (a) X-ray penetration; (b) rate of gas penetration; (c) rate of liquid penetration.

4. Electrical tests showing variations because of incomplete fusion, slag inclusions and porosity, in (a) electrical conductivity and (b) magnetic induction.

These tests, if used to the best advantage, would involve their application to each layer of deposited metal as well as to the finished weld. Except in unusual instances this would not be required by commercial practice, in which a prescribed welding process is carried out.

Relative Efficiency of Tests

Of the foregoing methods the visual examination is of more importance than is generally admitted. Together with it the chipping and calking tests are of particular usefulness. The latter test serves to indicate gross neglect by the operator of the cardinal welding principles, owing to the fact that only a very poor joint will respond to the tests.

The most reliable indication of the soundness of the weld is offered by the penetration tests. Obviously, the presence of unfused oxide surfaces, slag deposits and blow-holes will permit different degrees of penetration. Excellent results in the testing of small samples are made possible by the use of the X-ray. However, because of the nature of the apparatus, the amount of time required and the difficulty of manipulating and interpreting results, it can hardly be considered at the present time as a successful means to be used on large-scale production.

The rate that hydrogen or air leaks through a joint from pressure above atmospheric to atmospheric, or from atmospheric to partial vacuum, can readily be determined by equipment which would be quite cumbersome, and the slight advantage over liquid penetration in time reduction is not of sufficient importance to warrant consideration for most welds.

Of the various liquids that may be applied kerosene has marked advantages due to its availability, low volatility and high surface tension. Owing to the latter characteristics kerosene sprayed on a weld surface is rapidly drawn into any capillaries produced by incomplete fusion between the deposited metal and weld

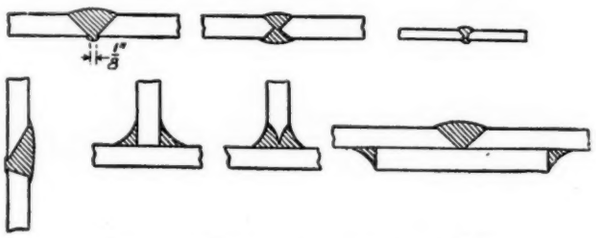


FIG. 1. TYPICAL ARC-WELD SCARFS

scarf, or between succeeding deposits, slag inclusions, gas pockets, etc., penetrating through the weld and showing the existence of an unsatisfactory structure by a stain on the emerging side. A bright-red stain can be produced by dissolving suitable oil-soluble dyes in the kerosene. By the means of this test the presence of faults that could not be detected with hydraulic pressure or other methods has been discovered. By the kerosene penetration a sequence of imperfect structures linked through the weld, which presents the greatest hazard in welded joints, could be immediately located. It must be borne in mind, however, that this method is not applicable to the detection of isolated slag or gas pockets, nor to small disconnected unfused areas. It has been shown by various tests that a weld may contain a considerable amount of distributed small imperfections without affecting to a great extent its characteristics.

If a bad fault is betrayed by the kerosene test, it is advisable to burn out the metal with a carbon arc before rewelding, under proper supervision.

Electrical test methods by which the homogeneity of welds is determined are still in the evolutionary stages.

Metallic-electrode arc welding is readily susceptible to close control. Regardless of the metal welded with the arc, the cardinal steps are:

(1) Preparation of weld; (2) electro selection; (3) arc-current adjustment; (4) arc-length maintenance; (5) heat treatment.

Sufficient scarfing, as well as the separation of the

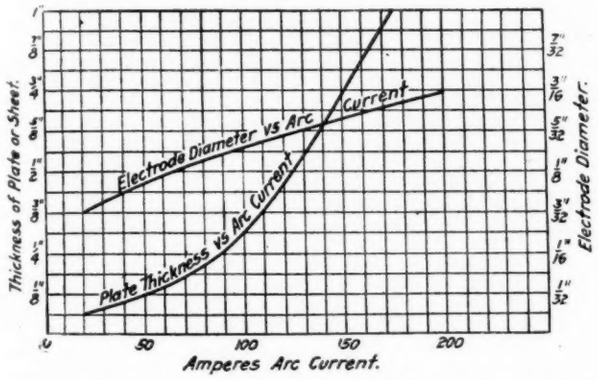


FIG. 2. ARC CURRENTS AND ELECTRODE DIAMETERS FOR WELDING STEEL PLATE OF VARIOUS THICKNESSES

weld scarfs, should be provided in the preparation of the weld, so that the entire surface will be accessible to the operator with a minimum amount of filling required. When necessary to avoid distortion and internal stresses due to unequal expansion and contraction strains, the metal is preheated or placed so as to permit the necessary movement to occur. Various types of scarfs in common use are shown in Fig. 1.

The electrode selection is determined by the mass, thickness and the constitution of the material to be welded. An electrode free from impurities and containing about 0.17 per cent. carbon and 0.5 per cent. manganese has been found generally satisfactory for welding low and high carbon as well as alloy steels. This electrode can also be used for cast-iron and malleable-iron welding, although more dependable results, having a higher degree of consistency and permitting machining of welded sections, can be obtained by brazing, using a copper-aluminum-iron alloy electrode with the aid of some simple flux. Successful results are obtained by brazing copper and brass with this electrode. The diameter of the electrode should be chosen with reference to the arc current used.

Effects of Too Low Current Values

A great many concerns have attempted welding with too low an arc current, and the result has been porosity and a poorly fused deposit. This practice has probably resulted from the overheating of most electrode holders on rated currents, thus leading the operator to come to the conclusion that the current used is in excess of the amount needed.

The approximate values of arc current to be used for given thickness of mild steel plate, as well as the electrode diameter for a given arc current, may be taken from the curve in Fig. 2. The variation in the strength of 1-in. (25-mm.) square-welded joints as the welding current is increased is shown in Fig. 3.

Notwithstanding that the electrode development is still in its infancy, the electrodes available are giving quite satisfactory results. However, considerable strides can yet be made in the ductility of welds, in obtaining consistent results, and in ease of utilizing the process.

The maintenance of a short arc length is imperative. A nonporous, compact, homogeneous, fused deposit results from a short arc, while a porous, diffused deposit results from a long arc. A skillful operator usually maintains a short arc, as the work is thereby expedited, less electrode material is wasted and a better weld is obtained, due to improved fusion, decreased slag content and porosity. By observing the arc current and arc voltage from meter deflections or instrument records, the inspector is able to keep a check on the most important factors which affect weld strength, ductility, fusion, porosity, etc. By the use of a fixed series resistance and an automatic time-lag reset switch across the arc to fix definitely both the arc current and the arc voltage, these important factors are placed entirely beyond the control of the welder and under the direction of the more competent supervisor.

Heat Treatment and Inspection

The method of placing the deposited layers has an important effect on the internal strains and distortion obtained during contraction. It is possible that part of these strains could be relieved by preheating and annealing, as well as by preparation for the movement of the metal.

The heat treatment of a completed weld is not a necessity, particularly if it has been preheated for preparation and then subjected to partial annealing. A uniform annealing of the structure is desirable, even in the welding of the small sections of alloy and high-

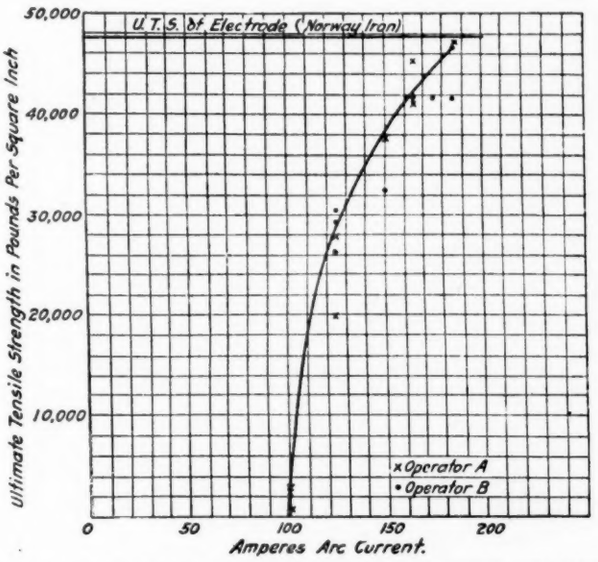


FIG. 3. VARIATION IN WELD STRENGTH WITH CHANGE IN ARC CURRENT

carbon steels, if it is to be machined or subjected to heavy vibratory stresses.

In addition to applying the foregoing tests to the completed joint and effectively supervising the process, the inspector can readily assure himself of the competency of any operator, or by subjecting sample welds to ductility and tensile tests or by simply observing the surface exposed on cutting through the fused zone, grinding its face and etching with a solution consisting of one part of concentrated nitric acid in ten parts of water.

American Power Equipment in Foreign Countries

By L. W. SCHMIDT

The last few years have been characterized by a steady growth in the influence of the American power industry in other countries. This growth has been one of method, of capital and of equipment.

THOUSANDS of dollars have been invested by Americans in foreign power enterprises since the war broke out, hundreds of American power engineers have gone into other countries to take charge of power plants or to supervise the construction of new enterprises, and the increase in the sale of power equipment to foreign countries amounts to many millions of dollars. American capital has not been invested in power enterprises only. Much capital also has flowed into mines, factories and similar undertakings requiring power equipment and this equipment has been ordered from American firms. In Venezuela, Colombia and Chile American mining firms are operating today, and incidentally they have opened to these countries dormant power resources.

America Aided Allies with Power Machinery

Much assistance has been rendered by the American power industry to the nations allied with the United States in the recent war. Power equipment was sent to France, England and Italy. The difficulties met by Chinese electrical undertakings in supplying power to the rapidly growing industry of China were eliminated by the ready assistance of the American industry, which undertook to furnish power machinery when no other country of the world was able to promise supplies.

The result has been a considerable increase in the American exports of power machinery. Dynamos, steam engines and boilers have been shipped in increasing quantities all over the world. Excepting Belgium, France and Italy possibly have suffered most from enemy invasion, and the two countries therefore have been most in want of industrial power equipment. Whole industries had to be reëstablished to replace the factories lost to these countries in occupied territory, and it was to America that they turned for the necessary equipment. There is no other way of measuring the extent of the American assistance than by comparing the values of the exports of power machinery to these countries with their purchases in pre-war time. France, for instance, raised her purchases of American dynamos from $7000 in 1913 to $159,000 during 1917. Only a few steam sets were sent to France during the war. The total value of all the boilers and boiler equipment shipped to France amounted to not much more than $20,000 in 1913, but during 1917 this had risen to approximately $1,000,000.

Italy bought from the United States much of the power equipment needed by her industries. She has made extensive use of her natural-power resources during the war so as to relieve her allies from the necessity of having to ship large quantities of coal. Thus, $290,000 was spent by her for American dynamos during 1917, against only $38,000 before the war, and $216,000 for electrical motors, which is a heavy increase over pre-war purchases. Her purchases of boilers and general equipment rose from $1100 to $120,000, approximately.

England, having a large power-equipment industry, made an extensive use of American power machinery only during the first years of the war. In 1915 the value of the dynamos that were shipped to England was $831,000, but after that the English industry appears to have been well able to take care of its own needs, with the result that exports declined until they reached $62,000 during the last year. There has been, on the other hand, an increase in the English demand for boilers and general power equipment.

Change of Direction of Export Trade

One of the most interesting features of our recent export trade in power machinery is the change that has taken place in the direction of this trade. Other countries, cut off from their usual markets, have turned to the American power industry for additional equipment. Norway, for instance, which in pre-war times was one of the least important customers of the American power-equipment industry, has suddenly come into prominence. The change that has taken place in this respect may be best understood when it is considered that the whole business connection with Norway as far as dynamos were concerned was worth exactly $111 to our industry in 1913 and that $168,000 was the value last year. Norway today probably is making better progress in the development of her natural-power resources than any other country of Europe. Her demands for electrical equipment, therefore, are exceptionally large. Not a single yard of electric cable was sent by our makers to Norway during 1913, but her purchases of American cable amounted to $318,000 in 1916 and $463,000 in 1917.

Spain in pre-war times was a very irregular customer for American power equipment, her purchases depending a good deal on the expansion of the business of the American-controlled power companies in Spain. During the early years of the war the Spanish orders decreased a good deal, but they now show a recovery and it is not unlikely that Spain will be one of the best markets for the American power industry after the war, for both electrical and steam supplies.

Export Business with Canada and Mexico

Turning to the American continent, the business with Canada has been most important during the last four years, but it has not been as active during the war as it was before. While Canada in 1913 took dynamos and generators valued at $585,000, her purchases remained considerably below that figure until 1917, when she bought these products to a value of $426,000. She also decreased her orders for American steam engines.

While governmental restrictions have been the principal reason for the reduction in the sales to Canada, political unrest was the cause of similar declines in the export of power machinery to Mexico. With order

and sound government returning in Mexico, there has been a return of orders for American power machinery. The total volume of trade, however, has not yet reached pre-war figures.

The Cuban power industry has been very active during the past year and business with the republic has been remarkably good. With the exception of 1915, when a sharp decline took place in the exports of power-house machinery to Cuba, export figures have been higher than before the war. During 1917 Cuba ordered from the United States dynamos worth $228,000, while her orders for stationary steam engines rose from $99,000 in 1913 to $195,000 in 1917. There has been also a demand for boilers, boiler tubes and general equipment, estimated to be about three times as high as in pre-war times.

South American Field Is Promising

South America has suffered a good deal from lack of capital. Before the war South American industrial enterprise was dependent almost entirely on European capital, with the result that most machinery was ordered in Europe. English and German electrical interests have reaped the principal benefit of this condition. When the war broke out, South America—particularly Argentina and Brazil—was suffering from an acute shortage of capital; consequently, industrial expansion was retarded and there was less demand for power equipment. The American power-equipment industry suffered as much as the European. Later, when American capital became available for the South American industries, conditions improved.

The turning point apparently was reached with the beginning of 1917, when larger orders for American power equipment began to flow in from South America. Argentina ordered American dynamos to the value of $23,000, and Brazil slightly more. There has also been an improvement in Brazilian business with reference to steam engines. Argentina as well as Brazil has recently shown much interest in American general power equipment, and a considerable number of orders were given during 1917 and the beginning of 1918.

The most promising of the South American markets for American power machinery at present is Chile. American capital has entered the mining industry of Chile on a large scale during the last four years, and the mines have been good customers for the American power industry. Practically all of the new equipment installed in the mines is of American manufacture, and orders for dynamos alone have grown from $15,000 in pre-war times to $137,000 during the last year. Increases also are recorded in the exports of many other kinds of power equipment.

American Equipment in China and Japan

A number of powerful dynamos of American construction have been installed in Chinese electrical works with the result that China in 1917 bought $222,000 worth of American dynamos instead of the $3000 spent by her in 1913 for the same purpose. Also there has been an increase in the Chinese purchases of American motors. Japan, on the other hand, has not bought so many American dynamos and generators since the outbreak of the war as in former years. She has increased her own production facilities and is now able to meet a large part of the national demand. The orders from Japan for American dynamos amounted to $245,000 during 1917. Japan further purchased American electric motors valued at $195,000 and stationary steam engines worth $36,000.

Australia received dynamos from this country to the value of $88,000 during 1917 and motors worth $720,000, while New Zealand took $35,000 worth of both. Many of the motors shipped from the United States to Australia, however, find their way finally to New Zealand.

The progress that has been made in the sale of American power machinery in other countries in recent years is only imperfectly expressed by figures; there is more to it than the mere sale of equipment. This equipment was sent abroad during a time when it could not be obtained anywhere else and when it was difficult for our own industry to spare it. Our manufacturers, nevertheless, have done their level best to help the foreign power consumers, and the assistance rendered in this way has been much appreciated. Repeat orders have been the result, and in several cases these stated expressly that the orders had been given for American power machinery because it had proved itself superior to the European machine equipment notwithstanding its somewhat higher price. This is a great compliment and no doubt the good will that has been built up for our industry will bear full fruit after the war. Also, foreign countries have become acquainted with American methods of power control and management.

Outlook for American Power Engineers

Time often was an object, so the equipment sent by our manufacturers could not be designed especially for the other market, but had to be taken from stock. The foreign customer, therefore, had to make himself familiar with American standards, and he has found that the American equipment fits in well with that of other countries and that in many cases it shows advantages over that already in use. So an objection frequently raised by foreign engineers against the employment of American power equipment has been removed, and the foreign competitor can no longer frighten the prospective customer away from buying American equipment on the score that it will not go with his existing installation. Only the American power engineer intent on selling American power equipment in other countries will be able to appreciate fully what this means for the future of the exports of the American power industry.

American engineers have gone out to the new markets to install our equipment and have acted as the teachers of power engineers in our new markets. These native engineers will do their part to increase the spread of our working methods in their countries, and the result will be a larger demand not only for our power equipment, but also for our engineers. South America should be the principal field of employment, but there are also the English colonies and Russia. All the countries of the world will require more power than they have needed before the war. American industrial methods will be employed widely, having proved their value during the war, and American engineers will have to act as tutors. Here is a chance for enterprising young engineers.

Maintaining Efficiency by Inspection and Tests

By J. O. KAMMERMAN

WHEN a customer receives a piece of apparatus from a manufacturer, he proceeds to use it without any doubts as to its reliability. He places confidence in it because of the reputation of the manufacturer, the successful operation of machinery previously purchased, guarantees furnished with the apparatus or recommendations of salesmen, consulting engineers and users.

It is the desire of every reputable manufacturer to place on the market apparatus in which full reliance can be placed because such a policy is the best selling agent obtainable. So he must be continually on the lookout for the highest grade of raw materials. He safeguards himself by frequent tests of the materials entering into his products and also by inspection of parts and of the complete apparatus. The inspection and tests are made rigid enough to convince him that the apparatus, when leaving the factory, will stand the normal stresses.

Machinery is often subjected to abnormal strains, and to safeguard against breakage under such conditions the designer employs a substantial factor of safety. In normal times competition is keen and the manufacturer must employ these measures in order to be able to maintain his product on the market, as reliability of operation and freedom from breakage are, after all, the main selling points. The responsibility for the successful operation of a piece of machinery rests upon the shoulders of the manufacturer. However, a great many failures due to abuse have been charged against him and he has often borne these with great fortitude.

Conditions today are abnormal. What was done in pre-war days cannot be accomplished now. Patriotic spirit compels coöperation in every way possible. The greatest aid that can be given is to conserve in every way raw materials and finished products. With orders for two and three years in advance, the labor problem increasing daily, raw material becoming more difficult to obtain and government restrictions to abide by, the manufacturer today is hard pressed to meet existing conditions. The time is at hand for both consumer and user to do all in their power to safeguard their present equipment and limit their orders for new apparatus to the bare necessities.

It is now time that the inspection and tests which the manufacturer made at the factory be continued by the user. Periodical test and inspection will often show up defects, due to deterioration and wear, which can be remedied without serious interruption of work, while if the fault is allowed to exist a failure of the apparatus will result when least expected, causing loss of time and production.

Some of the tests and inspections that can be made to safeguard against breakdowns are as follows: Electrical apparatus is subjected to test before it is placed in service to ascertain whether it will withstand the working pressure. Insulation will deteriorate and if insulation tests were made at stated intervals the gradual weakening could be detected and remedied with little loss of time and at a small cost. If a breakdown is allowed to occur, the apparatus is liable to be seriously damaged and human life may be endangered.

Static transformers rely on oil for insulation and cooling. Oil containing no moisture has a high breakdown, but if a small percentage of moisture is present the breakdown point is greatly reduced. Periodical tests of the oil will show the presence of water, which can be removed with little trouble and damage thus be avoided.

Rotating electrical machines are subject to bearing troubles. This class of apparatus usually operates with small clearance between revolving and stationary parts. A burned-out bearing, therefore, usually means more damage than that to the bearing. Inspections of the conditions of the oil, oiling devices and clearance can readily be made and faulty bearings replaced before a shutdown is necessary.

The insurance companies have helped to keep boilers and accessories in good shape. The manufacturer's inspection and tests do not suffice for a lifetime of boiler use. Inspection and tests made at stated intervals are required by insurance rules. These tests have prevented many boiler accidents and disclosed many minor faults which, when remedied, have increased the efficiency of the boiler.

Too much care cannot be taken in regard to the water supply, not only for boilers but for drinking and other purposes. Contaminated water causes sickness among employees and the resultant lay-off is as detrimental as a machine breakdown. In many instances where water-softening plants are installed, operators become careless as to the amount of softener used. It is false economy to try to save on the amount of softener used, and it is also a waste of money to have a softening system installed and not operated at the maximum efficiency. Samples of water taken at intervals and tested both for boiler uses and for contamination will prove to be economical.

Inspection should not stop at the boiler. All steam-line accessories should be inspected to assure proper operation and turbines carefully watched to detect any tendency for deposits to form. Condensers are necessary for efficient operation and a leaky condenser defeats the purpose for which it is installed. Deposits here reduce the capacity of the condenser, and while washing may be done regularly, it may not clean the condenser. An inspection of surface and tubes is necessary to determine the efficiency of the cleaning process and to assure proper operation.

Too often, care and attention are given to the main units and no attention is paid to the small auxiliaries until one of them fails and causes a shutdown. The old statement that the chain is no stronger than the weakest link applies here. The inspection should be made complete and all parts of a system carefully considered.

With forced production and new and unskilled labor to contend with, machine tools should be carefully watched. If they are allowed to run till the operator reports a broken part, the machine may be out of service for some time, with consequent loss of production. The inspector should thoroughly examine not only the machine, but the methods of the operator. A word of caution or advice to a new or unskilled employee will often save damage to a machine.

No attempt is made here to outline all the necessary parts that should be inspected in power plants, machine shops and manufacturing establishments. The purpose is to call to the attention of operators that the apparatus they are using was carefully inspected and tested before it was delivered and that maximum efficiency depends on keeping it in at least as good condition as when delivered, which can be effected only by inspection and tests. The cost of inspectors may seem like a waste of money, but one bad breakdowr will often pay for many days of an inspector's time.

The CoKal Stoker

Most small boiler installations have been equipped with hand-fired furnaces mainly because the stationary or shaking grates were cheaper to install. Recently, several types of stokers have been developed to meet the requirements of small boiler plants, among them being the CoKal stoker, manufactured by the CoKal Stoker

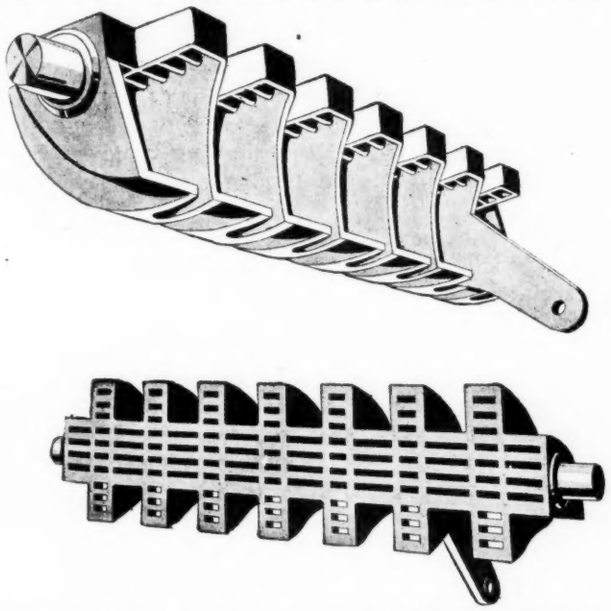


FIG. 1. REAR AND TOP VIEWS OF THE STOKER BAR

Co., 48 Division St., Chicago, Ill. In appearance the stoker resembles the dumping type of shaking grate, but it is not one.

The frame bearing bar is 3 in. below the fire. The stoking bars of which the grate is composed are set in the frame bearing bar and are prevented from dropping out of place by lock clips. In case stoking bars are damaged, they are easily removable. They are so designed as not to warp, buckle, or sag, and although hollow, they are strengthened by stiffening pieces, as shown in Fig. 1. The tops of the bars are flat and are provided with adequate air space, and they are staggered so as to interlock, thus forming an unbroken surface when all grates are in the operating position. Another feature of the stoker-bar construction is that as they are rocked to move the fuel toward the bridge-wall, the arc of the circle is such as to keep the space between them the same regardless of their position.

In operation the stoker resembles hand-fired grates with the coking methods. The fuel is fired into the firing doors in the usual manner, but instead of being spread evenly over the stoker surface, it is heaped up at the firing door as it would be with a hand-fired grate using the coking method (see Fig. 2). The distilla-

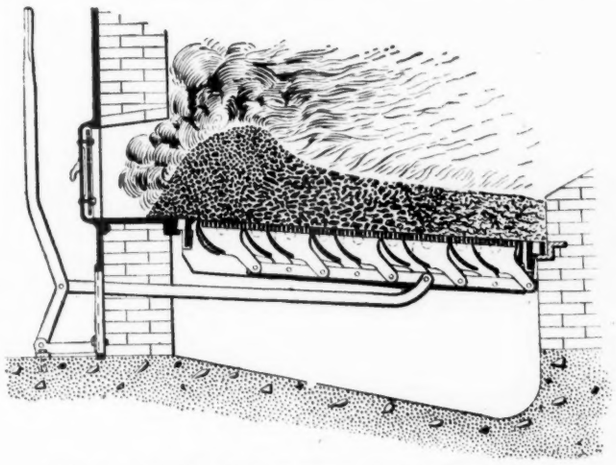


FIG. 2. CONDITION OF FUEL BED AFTER FIRING

tion of volatile gases from the coking fuel at the furnace front is consumed in passing over the hot fire at the rear of the furnace. As the fire burns down, it is necessary to move the coal toward the rear of the furnace, and this is done by moving the lever that connects with the operating bar of the stoking bars to and fro through an arc of 45 deg. This also moves the ashes and refuse toward the rear section, and these are dumped into the ashpit by pulling the same lever down all the way, as shown in Fig. 3. It will be noticed that when the stoking bars are in the dumping position, no coal is permitted to pass into the ashpit between the bars on account of the construction already mentioned, and only ash and refuse are dumped through the opening made between the last stoking bar and the bridge-wall section.

The old method of cleaning fires has been done away with and there is no necessity of opening the furnace

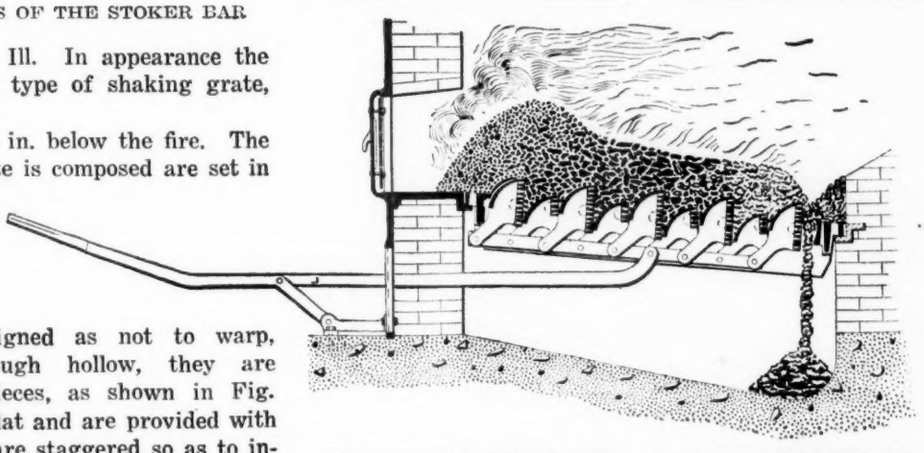


FIG. 3. WORKING THE FUEL AND ASHES TOWARD THE BRIDGE-WALL

door to perform this operation; in reality the fires are self-cleaning, which insures a clean fire from one end of the run to the other. Naturally, with the elimination of the ash practically as fast as it is formed, there is but little clinkering.

Practical Application of Kirchhoff's Law

By V. J. KUBANYI

WHERE it is required to find the current through a circuit supplied from two or more independent sources which have equal electromotive forces and internal resistances and are connected in parallel, the problem can be easily solved by simple Ohm's law calculations.

For example, in Fig. 1, it is required to find the voltage E_a applied to r_3, and the current through it. The open-circuit pressure of the battery is 20 volts and the internal resistance of each group of cells is 2 ohms. By the law for sources of equal electromotive force in parallel, the open-circuit voltage of the two groups of cells in parallel is that of one group, or, in this case, 20 volts. The joint internal resistance of the batteries in parallel is R_b which is half that of one group, or 1 ohm. The resistance of the entire circuit is therefore $R = R_b + r_3 = 1 + 9 = 10$ ohms

The current flowing through r_3, then, is $I = \frac{E}{R} = \frac{20}{10}$ = 2 amperes. The volts drop through each battery is

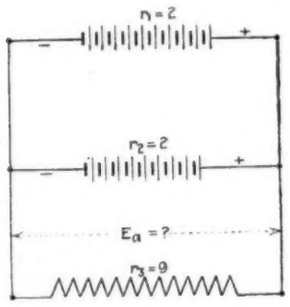


FIG. 1

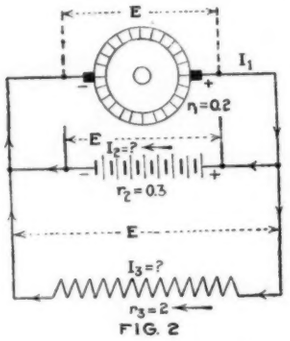


FIG. 2

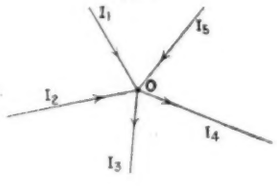


FIG. 3

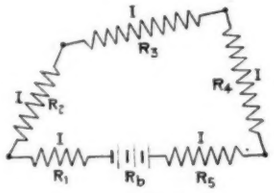


FIG. 4

FIGS. 1 TO 4. DIAGRAMS ILLUSTRATING THE APPLICATION OF KIRCHHOFF'S LAWS TO CURRENTS AND ELECTROMOTIVE FORCES

$E_d = R_bI = 1 \times 2 = 2$ volts. Therefore the voltage available at the terminals of r_3 is $E_a = E - E_d = 20 - 2 = 18$ volts.

The foregoing problem is very simple to solve, but if two or more sources of unlike electromotive forces having unequal internal resistances are connected in parallel and furnish current to an outside circuit, as in Fig. 2, the problem becomes somewhat more involved.

In order to solve this problem Kirchhoff's laws have to be resorted to. These, however, are only a development of Ohm's law, but nevertheless they complicate matters somewhat until explained.

In Fig. 2 the generator has an open-circuit voltage of $E_1 = 120$ volts and an internal resistance of 0.2 ohm, while the storage battery develops a voltage $E_2 = 110$ volts on open-circuit and has an internal resistance of 0.3 ohm. Both the generator and battery are connected in parallel to an external circuit r_3 of 2 ohms resistance. By inspection it is impossible to determine whether the generator will charge the battery or the battery discharge through the external circuit r_3. In addition to determining which is the case, we also wish to determine what the voltage across the circuit will be while the current is flowing.

Kirchhoff's first law states: The algebraic sum of the currents that meet at any point is zero. This means that whenever conductors carrying currents are joined together at a point, the sum of all the currents flowing to that point is equal to the sum of all the currents that leave or flow away from the point. For example: In Fig. 3 the currents I_1, I_2 and I_5 are flowing toward the point O and the currents I_3 and I_4 are flowing away from O. In this case $I_1 + I_2 + I_5 = I_3 + I_4$ or $I_1 + I_2 + I_5 - (I_3 + I_4) = 0$. The foregoing equations show that the algebraic sum of the currents at a point is zero; also, the sum of the currents flowing to a point equals the sum of the currents flowing away from it. This is self-evident, since we could not have any more or less current flowing from a point than flowed toward it.

Kirchhoff's second law states that the algebraic sum of the products of the current and resistance of each part of a series circuit is equal to the electromotive force of that circuit. That is, in any such circuit the algebraic sum of all the products obtained by multiplying the resistance of each conductor by the current flowing through it added to all the electromotive forces encountered in the circuit will be equal to zero. Care must be taken that the algebraic signs of the electromotive forces are correct. Fig. 4 will illustrate this; here the open-circuit voltage $E_1 = R_1I + R_2I + R_3I + R_4I + R_5I + R_bI$, or $R_1I + R_2I + R_3I + R_4I + R_5I + R_bI - E_1 = 0$.

We now have a foundation upon which to reason out a solution of the problem in Fig. 2. Assume the currents to flow as indicated by the arrowheads. It is assumed that the battery is being charged; that is, the generator is supplying current to it as well as to the resistance r_3. If this assumption proves incorrect it will be indicated by the fact that the value for I_2 will come out a negative quantity in the problem, which would mean that the arrow indicating the flow of the current in the battery circuit should be reversed; that is, that the battery is aiding the generator by discharging through r_3.

Making use of Kirchhoff's first law, we have (1) $I_1 - (I_2 + I_3) = 0$. Considering the generator and battery circuit alone, we have (2) $r_1I_1 + r_2I_2 = E_1 - E_2 = 120 - 110 = 10$, from which $r_2I_2 = 10 - r_1I_1$, and

(2a) $I_2 = \frac{10 - r_1I_1}{r_2} = \frac{10 - 0.2I_1}{0.3} = 33.333 - 0.667I_1$.

Considering the generator and outside circuits together we have (3) $r_1I_1 + r_3I_3 = E_1 = 120$, from which $r_3I_3 = 120 - r_1I_1$ and $I_3 = \frac{120 - r_1I_1}{r_3} = \frac{120 - 0.2I_1}{2} = 60 - 0.1I_1$. Substituting the value for I_2 and I_3 in equation (1) we have $I_1 - (33.333 - 0.667I_1 + 60 -$

$0.1I_1$) = 0, from which $1.767I_1 = 93.333$, and $I_1 = 52.82$ amperes. Substituting the value of I_1 in $I_2 = 33.333 - 0.667I_1$ gives $I_2 = 33.333 - (0.667 \times 52.82) = -1.898$ amperes. Since the answer is negative, the battery must be discharging and we must reverse the arrow for the battery current in Fig. 2 to show the proper direction of flow.

From $I_2 = 60 - 0.1I_1$ we have $I_3 = 60 - (0.1 \times 52.82) = 54.718$ amperes. Since both the battery and generator furnish current to the external circuit the sum of their currents must equal $I_3 = 54.718$ amperes; but we have also that $I_3 = I_1 + I_2 = 52.82 + 1.898 = 54.718$ amperes which checks our result. Knowing the current and resistance of all the circuits, the voltage E across them can be found in the following ways: $E = r_3I_3 = 2 \times 54.718 = 109.436$ volts, or $E = E_2 - r_2I_2 = 110 - (0.3 \times 1.898) = 109.436$ volts, or $E = E_1 - r_1I_1 = 120 - (0.2 \times 52.82) = 109.436$ volts, all three giving the same value.

There is another method of working out this problem; it differs slightly from the foregoing and will also serve as a check on the other. Assume the generator current to be x and the battery current to be y then $x - y$ will be the current passing through the circuit r_3. The voltage E across the circuit will be $E = 120 - 0.2x$, or $E = 110 + 0.3y$, or $E = 2(x - y)$, from which $120 - 0.2x = 110 + 0.3y$, and by transposition $0.3y = 10 - 0.2x$; hence,

$$y = \frac{10 - 0.2x}{0.3} \qquad (4)$$

$120 - 0.2x = 2(x - y)$, and by transposition $2y = 2.2x - 120$; hence

$$y = \frac{2.2x - 120}{2} \qquad (5)$$

Since y of equation (5) must equal y of equation (4), we have: $\frac{2.2x - 120}{2} = \frac{10 - 0.2x}{0.3}$ or $0.3(2.2x - 120) = 2(10 - 0.2x)$ from which $0.66x - 36 = 20 - 0.4x$ therefore $1.06x = 56$ and $x = 52.83$ amperes. Substituting in equation (5) the value of x,

$$y = \frac{(2.2 \times 52.83) - 120}{2} = -1.887 \text{ amperes.}$$

The current comes out negative as before, showing that the battery is discharging. The current in the external circuit equals $x - y = 52.83 - (-1.887) = 52.83 + 1.887 = 54.717$ amperes. This checks up with the current in the first problem.

It should be noted that the effect of armature reactions in reducing the generated voltage E_1 of the generator has not been taken into account in the foregoing discussion. For an interpole machine, however, the effect may be considered as negligible.

Saving Coal at the Mines

BY J. R. THOMAS

Much is and has been said about saving coal, and many plants have installed the best of machinery for that purpose and are obtaining good results. But I have failed to see at any of the collieries that I have recently visited any serious attempt at saving coal. Although it may seem a small item, a lot of coal can be saved at the mine by the judicious operation of the mine motors and hoisting engines.

Some mines have good signal systems to let the motorman know when there is a trip ready for him, but there are many mines where the motor is continually going to and fro, looking for coal.

In one instance enough power was saved to operate a pump in the mine by regulating the trips on a steep slope. There were two lifts on this slope and a pump located at the lowest point of the slope, all of which were operated by compressed air. There were about 80 persons continually employed down this slope, and it was customary for each one to get a ride up as soon as he arrived at the lift, therefore the slope engine was kept continually running, and as the compressors on the surface were already taxed to capacity, the sump pump had to be operated on the night shift, which meant an extra expense. One day the foreman noticed that in ten minutes' time there were two round trips made from the bottom to the top with only five men altogether, and when word came that there was a trip of coal in the first lift, and the triprider went after it, the engine was "stuck for air" and had to wait until the pressure was up again. It was then that the foreman realized that if there were not so many empty trips there would be air when they had coal to hoist and issued orders that a trip for men would be allowed only when there were ten men at the lift to come up. After these orders were put into effect, the pressure on the gage stood at 80 lb. and the engine was not "stuck" all day. It was then suggested that there was a chance to operate the pump on the day shift, and it was found that neither the pump nor the engine was stuck for air. Instead of the engine making from twenty to thirty unnecessary trips per day, the pump could run and use the air previously wasted. This is only one of the many instances where coal and power are wasted in the mines. All unnecessary hoisting means a waste of fuel that we are urged to save, and mine foremen as well as engineers can do a great deal to save coal right where it is mined.

Duriron Centrifugal and Reciprocating Pumps

In certain lines of manufacture it is necessary to pump acid or water containing acid, and it is easily understood that the ordinary pump will not handle these

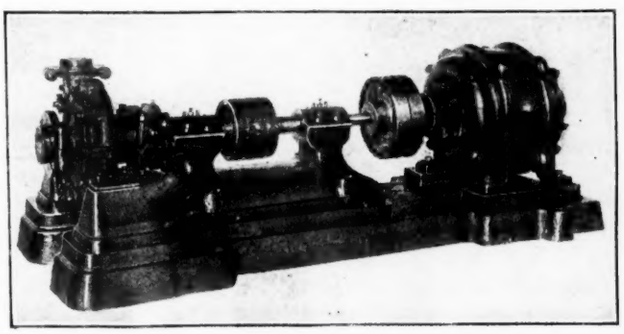


FIG. 1. DURIRON CENTRIFUGAL PUMP

liquids successfully without suffering from erosion. Various methods have been more or less successfully employed to protect the metal part of the pumps used in handling acid or acid water. One construction, al-

though not new, is of interest inasmuch as the metal of which it is composed combines the acid and alkali resisting properties of glass with the strength and other desirable properties of cast iron as well as certain properties distinctively its own. This metal is called "Duriron," and because of its extreme hardness it is highly resistant to erosion. It is so hard that it cannot be ma-

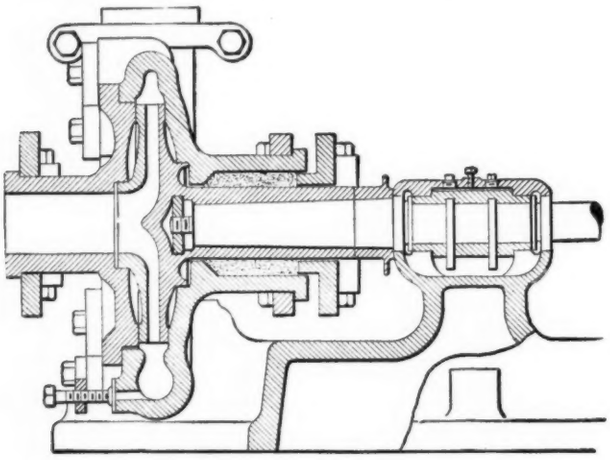


FIG. 2. SECTION THROUGH THE PUMP

chined with a cutting tool, but is finished by grinding. Fig. 1 shows a motor-driven centrifugal pump, manufactured by the Duriron Castings Co., Dayton, Ohio.

One of the principal difficulties with centrifugal acid pumps has been leakage at the stuffing-box. In this pump a type of impeller has been introduced which does away with any tendency to leak at this point. Oversize annular seals have been provided on both sides between the impeller and the casing. These allow for considerable wear on the bearings and consequently end play without influencing the proper working of the pump. The seals reduce the slip and prevent leakage at the stuffing-box.

The base of the machine is arched to prevent accumulation of liquid, and as all parts are made to gage, they are interchangeable. The casing, impeller and cover are made of "Duriron," the bearings of bronze and the shaft is of steel. The remaining parts of the pump are of iron with the exception of the glands, which are of "Duriron." Fig. 2 is a section through the pump.

The design of reciprocating pump is shown in Fig. 3. All parts coming into contact with solutions are of "Duriron" and are interchangeable. The valves and seats are usually of the same metal.

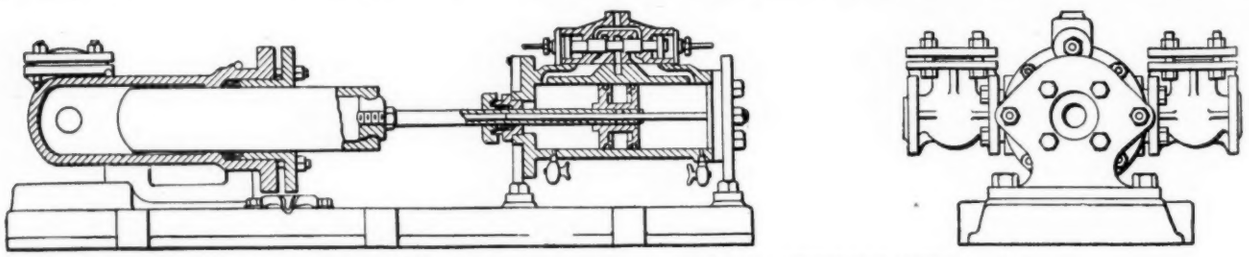


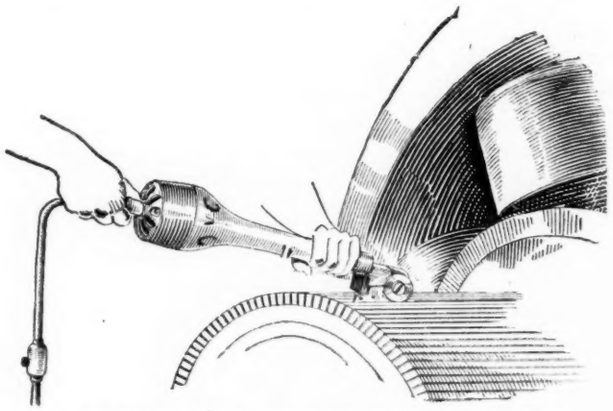
FIG. 3. SECTIONAL AND END VIEWS OF DURIRON RECIPROCATING PUMP

It is well for firemen to keep in mind the fact that the circular thingumbob in the center of the fire-door was not put there merely as an ornament.

Aurand Commutator Slotter

Every engineer who has operated motors and generators has had experiences with high mica between commutator segments. This gives trouble and also entails extra labor in removing the high strips of mica insulation left between the segments as they wear down. A machine that will undercut this mica insulation is known as the Aurand commutator slotter and is a hand-operated and power-driven machine which can be used without first having to remove the brushes, brushholder, etc., of the motor or generator.

The essential parts of the machine consist of a 2-in. circular saw keyed to a hollow mandrel which carries a worm gear; a hollow handle, which holds a steel shaft



APPLICATION OF THE COMMUTATOR SLOTTER

and small motor, and a thin metal guide which slides in the slot immediately behind the saw. The machine is provided with adjustments that make it serviceable for any size commutator and allow slotting at various depths.

The reduction gear permits the saw to be run at a speed most suitable for obtaining the best results. The standard machine is equipped with a 115-volt d.c. motor, but motors for other voltages, or for alternating current can be furnished.

On large machines the rate of cutting is from 20 to 30 in. per minute and the life of the saw depends, of course, upon the condition of the mica, but averages from 100 to 150 ft. This device is manufactured by Frank E. Aurand, 123 South Cuyler Ave., Oak Park, Illinois.

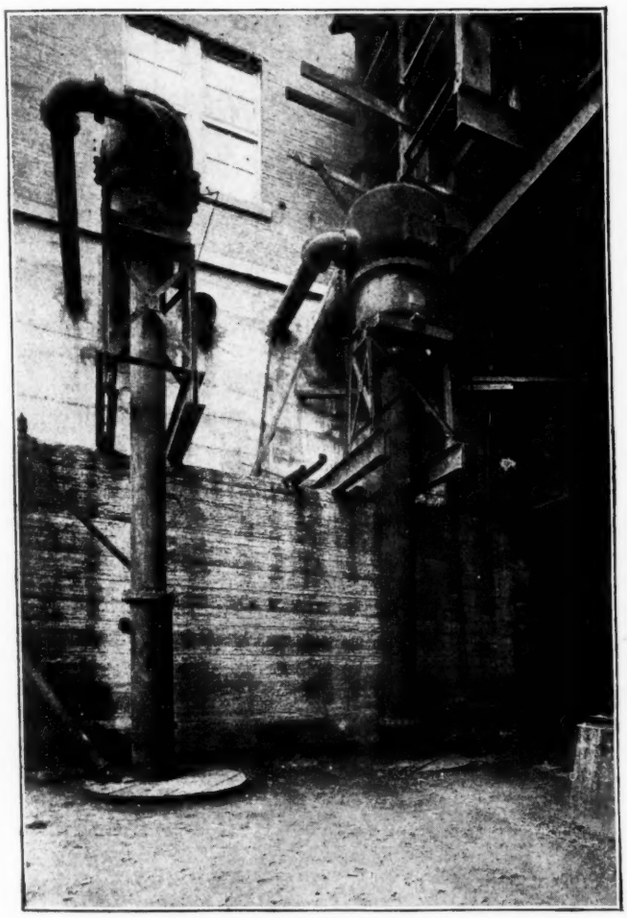
All that has been learned of ways of conservation will become increasingly valuable as time goes on, and conservation will again become a necessity as well as a virtue. There must be no backward step or relaxation.

Ideal Barometric Condenser Conditions

By G. T. Keech, Jr.
Engineer, Westinghouse Electric and Manufacturing Company

THE four important factors to determine ideal conditions are as follows: Topography of ground; water levels; kind of water; installation and operating costs.

The topography should be such that the condenser may be bolted directly to the turbine exhaust. The two losses to consider in exhaust piping are air leaks and the head lost because of friction of the steam in the piping, and consequently, the shorter the exhaust pipe to the condenser head the more nearly will the performance meet that of the low-level jet condenser. Barometric condensers are usually designed to give the same performance as low-level jet condensers, if the vacuum is measured at the condenser head and not at the turbine exhaust. By the same performance is meant the same ratio of water to steam for a given vacuum. Thus the effective vacuum, or the vacuum realized at the turbine exhaust, is directly dependent on the drop in pressure in the exhaust line between the turbine and the condenser. Thus the ideal plant in which to place a barometric condenser would be situated on the side of a steep hill or on a steep river bank, where there should be available a sufficient supply of cooling water above the condenser head, or at least, within the suction lift of the vacuum.



BAROMETRIC CONDENSERS AT MINNEAPOLIS

The second factor making up the ideal condition is water level. Within certain limitations the vacuum in a low-level jet condenser or a barometric condenser body will be able to draw in the condensing water. Theoretically, the operating vacuum will lift the water about 30 ft., but this lift should be limited to approximately 18 ft. to take care of the fluctuation in load, pipe friction and spray-nozzle friction. Therefore, for the ideal condition the injection water for a barometric condenser should be available at a distance of not over 18 ft. below the center line of the injection inlet to the condenser head. Even if the water supply is available at this head, it will be necessary to supply means of pumping it to the condenser head to start the condenser and establish the vacuum. After the vacuum is established, it will then pull the water over this vertical lift. So, for an ideal installation one would look for a plant so situated that the water supply is on a level with the condenser injection line or even a few feet above it. This would eliminate the pumps necessary to put the condenser in operation and would permit of more rapid starting. The level of the water in the tailrace should be approximately 35 ft. below the bottom of the condenser head. This vertical distance is necessary because a 29-in. vacuum will hold up a column of water approximately 33 ft. high, and that the water may run out from the condenser tail pipe it is necessary that the pipe be at least 35 ft. Therefore, for the ideal conditions the difference in inlet- and outlet-water levels should be 40 ft. or more, and the minimum distance to be considered should be 40 — 18 = 22 ft.

Kind of Water the Third Important Factor

With the worst water conditions possible, which means warm acidulous water, the barometric condenser competes with either the surface or the low-level jet type of condenser. It does not have expensive pump parts which can be affected by such water and require frequent replacing. Instead, the only part of a barometric condenser that comes in contact with the warm water is the cast-iron tail pipe, and that is much cheaper to replace than muntz-metal tubes or bronze pump runners. The ideal barometric-condenser installation will not be affected by the kind of water available; and it might be that a poorer water, such as warm acidulous water, would force a decision for this type of condenser.

The final factor to be considered in determining an ideal barometric installation is the cost of installation and operation. The pumping heads should be carefully checked for each type of condenser to find out where the three types stand as to power requirements for pumping.

The locations where the correct water levels are available are few. As a concrete example of ideal barometric-condenser conditions, the writer has in mind the barometric condensers installed in the flour-mill district at Minneapolis, Minn. Here the Mississippi River has a drop of 68 ft. in a distance of about three blocks. This drop is at the St. Anthony Falls and the rapids just below the falls. Water from the upper river level is conducted in canals parallel with the river banks and carried to points below the falls. The river banks below the falls are steep and form a gorge, so that the flour mills are really at the upper water level. Injection water is run from the canals to the condenser head,

dropped through the tail pipe and run out through a tunnel to the lower water level.

The Pillsbury flour mills have three barometric condensers serving three turbines. The power house is on the river bank, and the level of the turbine-room floor is such that the center line of the turbines is slightly over a foot above the injection-water level in the canal. The turbines are set on the side of the power house next to the river. Then the barometric condensers, instead of being directly under the turbine exhaust, are hung just outside the power house wall as shown in the accompanying illustration. The vertical distance from the canal water level down to the center line of the injection inlet on the condenser head is from 5 ft. to 6 ft. The distance from the injection-water inlet to the water level in the tailrace is 41 ft. The water from the tailrace flows through a short tunnel and is discharged into the lower river level at a short distance below the plant. As the illustration shows, the condenser is of the side-inlet type, the exhaust line being a short piece of exhaust piping running directly from the turbine exhaust to the condenser head. Directly across the river from the Pillsbury plant is that of the Northwestern Consolidated Milling Co., also using barometric condensers.

Some Power-Plant Troubles

BY THOMAS SHEEHAN

A CERTAIN power plant was small but growing fast, and when changes were to be made the company always employed a consulting engineer, who specified, ordered material and had installed whatever apparatus was to go in. The engineer in charge, however, knew nothing of any changes until they were begun.

On one occasion a blowoff tank for the boilers was

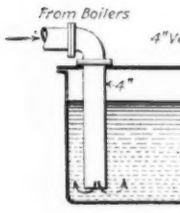


FIG. 1. SUBMERGED PIPE END

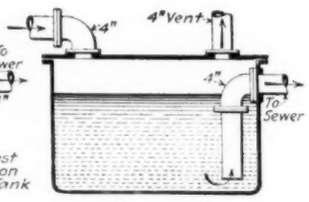


FIG. 2. OPEN PIPE END

being installed and the steamfitters had worked a couple of days connecting it up, when the engineer saw that they were so connecting the blowoff pipe from the boilers that the end would be submerged, as shown in Fig. 1. He pointed out the danger of blowing off with 150-lb. pressure, as there would be quite a water-hammer and the pressure would not only blow the water out of the tank, but would also blow steam into the sewer. The consulting engineer had the drawings changed and the pipe arranged as shown in Fig. 2, which allows the steam to escape through the vent and the water to flow to the sewer.

The discharge from the tank was piped to the sewer as shown in Fig. 3. After the blowoff had been used two days, steam was seen coming up through the ground along the line of the sewer, and it was found that about six lengths of tile pipe was cracked and had to be renewed. A cement tank was then built over the sewer pipe (Fig. 4) with a manhole grating on top. The next job was a 10-in. exhaust heating main that ran about 300 ft. in a tunnel with a 5-in. return to the vacuum pump. It was in service a week when two 45-deg. ells in the 10-in. line were broken, owing to a water-hammer. The night fireman was the only one in the plant at the time, and there is no knowing what the conditions were. However, the engineer suggested re-

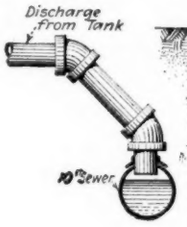


FIG. 3. PIPING TO SEWER

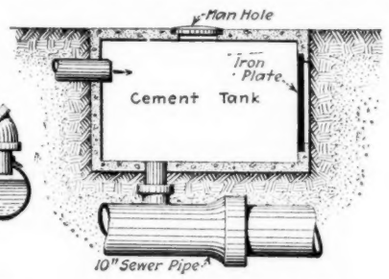


FIG. 4. CEMENT TANK OVER SEWER PIPE

moving the vacuum valve from the upper position *A* to the lower position *B*, Fig. 5. He reasoned that the valve was so close to the 10-in. main that the valve and water in it did not have a chance to cool off and allow the valve to open. After the change there was no more water-hammer.

A 1000-hp. open feed-water heater was installed to take the place of a 300-hp. closed heater that was considered too small. With the latter the feed-water temperature was always 210 deg. or more. But with the open heater the temperature was liable to be most anything. A 1½-in. pipe from the city water supply was connected to the suction pipe from the heater so as to cool the water going to the pump in case it got too hot. The second day the heater was in commission, there was 2 lb. back pressure on the heater and heating system. When the engine was shut down at noon, the pounding of the feed pump could be heard a block away.

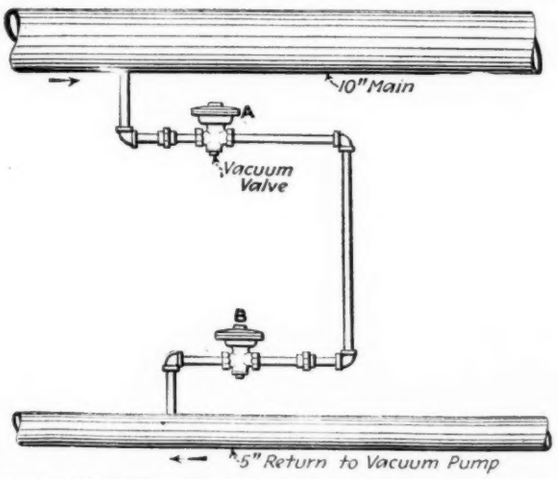


FIG. 5. FORMER AND PRESENT POSITION OF VACUUM VALVES

When the back pressure was removed, the water in the heater started to boil and the pump became steambound. The fireman, thinking the pump had lost its water, opened the city-water valve. This stopped the pump from pounding, but flooded the heater with cold water and resulted in a drop to 75 deg. in the feed-water temperature. It was some time before the temperature was

again normal. The following Sunday a check valve was placed between the heater and the city-water pipe.

On top of the heater there was a 6-in. vent pipe and a 6-in. gate valve. An old exhaust head that was in the plant was placed on the end of the pipe, as shown in Fig. 6. The engineer could not understand why the vent pipe was so large, as there was a 12-in. pipe lead-

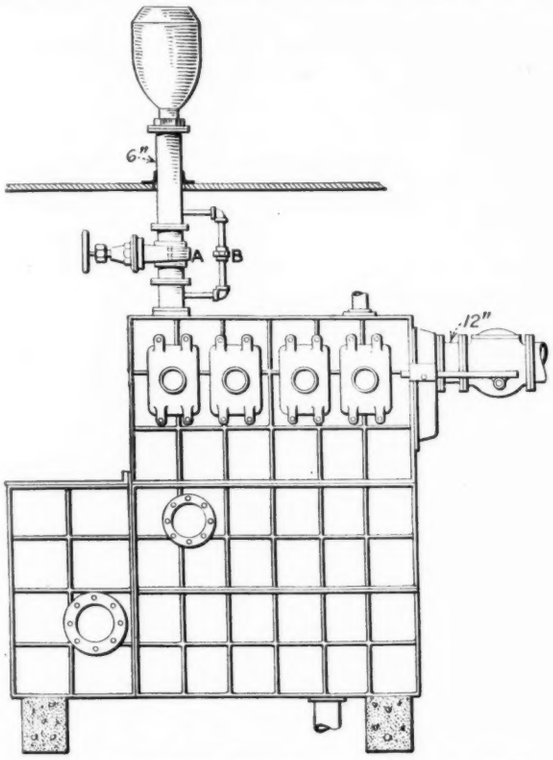


FIG. 6. HOW THE VENT PIPE WAS ARRANGED

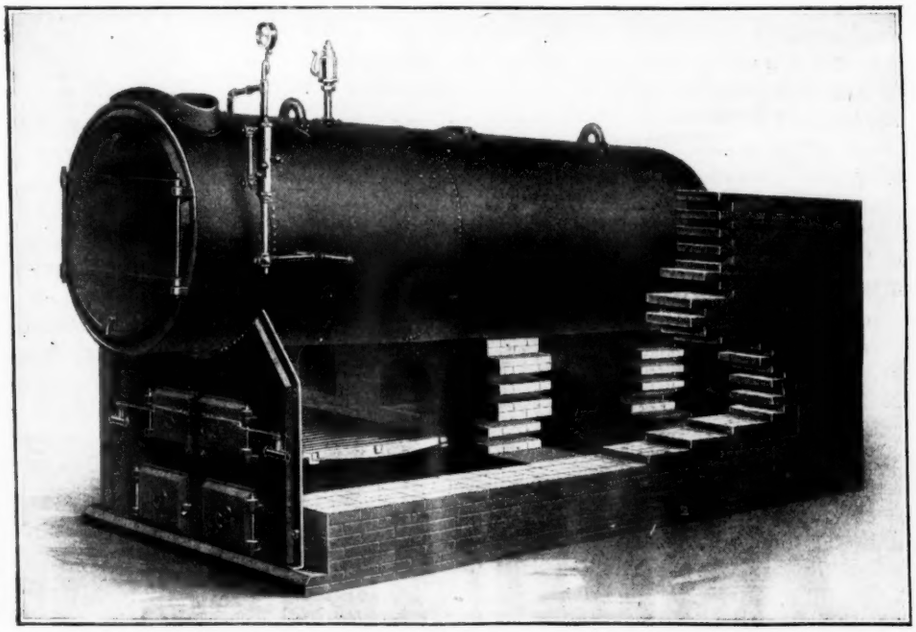
ing to the atmosphere with a back-pressure valve just before entering the heater. When this valve was closed, the feed-water temperature would drop to about 180 deg., evidently from air accumulating in the heater, and when it was opened there would not be any back pressure on the heating system and so it was a case of keeping on trying and watching the thermometer on the feed pipe to get it adjusted, which takes some time with a gate valve. After a little practice it was possible to regulate the back pressure on the engine with the vent-pipe valve. The engineer suggested either boring a hole through the valve, as shown by the dotted lines at *A*, or putting a 1¼-in. bypass around the valve, as shown at *B*. This would vent the heater and the valve could be kept closed. Three months after the heater was installed, a man came from the shop to test the accuracy of the recording V-notch meter, but he could not tell why the vent was made 6 inches.

Automatic Air-Controlled Furnace

Bituminous coal is high in volatile; in other words, it contains a relatively large percentage of material that in the presence of high temperatures will distill readily and release large volumes of gas. As this suddenly released gas may contain as high as one-third of the heat value of the coal, it is important that it be supplied with the proper amount of air for complete combustion and that means be provided to thoroughly mix the gas and the air. One way to fulfill these conditions in the usual hand-fired furnace is to admit air over the fire for a short period after firing, and to provide arches or baffles that will insure a proper mixture.

To obtain high economy, one of the essentials is a hot fire, the rapidity of burning being regulated by the damper. Firing intervals should be determined by the condition of the fire rather than by indications from the steam-pressure gage. When coal is spread evenly in a thin layer over a hot fire, it gives off the largest volume of gas immediately after firing, the volume decreasing until the volatile has been distilled. To supply the seven volumes of air to one of gas needed for good combustion, the air must be admitted over the fire in decreasing volume or in direct proportion to the formation of gas.

For a number of years the Automatic Air Furnace Co., of Chicago, has been studying the problem expressed in the foregoing. A simple device has been developed to control automatically the closing of the firing door and consequently regulate the air over the fire. It is spring-actuated, movement being effected by a rack-and-pinion gear controlled by an oil check. The size of the oil orifice may be varied at will, so that the time of closing may be adapted to different fuels. The simplicity of control is an outstanding feature. If any defect should develop in the mechanism, operation of the furnace may be continued in the usual way. The device is mounted on the boiler front and is attached to the firing door by suitable levers that permit the door to remain open while the charge is being fired. It will be



SHOWING FURNACE-DOOR CONTROL, BRIDGE-WALL AND BAFFLE

noticed that the door is wide open when the largest volume of air is required and that it gradually closes as the formation of gas decreases. During the rest of the firing interval the air is admitted through the grates as usual.

To mix the air and gas a built-up bridge-wall with port openings of proper dimensions and an arch across the combustion chamber are employed (see illustration). The gas areas through the bridge-wall and between the bridge-wall and the fire arch are determined by the grate surface, draft, tube area and the existing operating conditions. Application of the design may be made in return-tubular and horizontally baffled water-tube boilers.

Outside Versus Recirculated Air

Since ventilation cannot at present be called an exact science, and as its practice cannot be standardized, a general discussion is permissible and may be beneficial.

There are two common methods of securing ventilation or wholesome air to breathe. The one that first comes to mind is nature's own—an ocean of fresh air in which we are submerged like fish in water, kept in motion by the motion of the earth, an elaborate fan system, and shifting areas of high and low barometer. This gigantic system together with the heating plant originally supplied both quantity and quality. In the construction of buildings both the quantity and quality of the air within these buildings has been changed. Whether for safety, privacy or the conservation of bodily warmth, the free circulation of air is more or less obstructed. It is possible to so construct buildings that ventilation will not be seriously interfered with, but the demand for artificial heat is directly proportional to the quantity of air admitted and its condition as to temperature, humidity, etc. Ventilation is therefore usually subordinated to heating when artificial heat is required. The relative importance of each is a matter that is usually decided on the basis of bodily comfort, economy or laziness.

Since producing heat has a money or labor cost attached to it and outside air often requires to be heated, a minimum of outside air is often admitted. Moreover, outside air is not always wholesome and its introduction into large buildings is often through ducts that are hard to keep free from dust and odors, so that a great inflow of air may not provide a wholesome atmosphere. As in nature, therefore, an adequate purifying process must be carried on to meet the artificial conditions. A balance must be struck between the cost of heat and the conditioning of the air. If heat costs little, a great quantity of air of ordinary quality may be used; but as the cost of heat increases, the quantity of cold air is naturally restricted and the question arises, "Why bring in and condition cold air at great cost in heat and dissipate the air already heated?" The chances are that conditioning the air already in a room or building will, one day, be done at much less cost than treating and heating cold air from the outside can be done. An adequate quantity of well-conditioned air is better than a hurricane of wind that lacks the blood-cleansing elements. A basin of clean water and a good soap will cleanse the hands better than a river of polluted water.

The whole question for the future seems to depend on the relative cost of heating and conditioning air, with indications pointing toward recirculation and conditioning the air as the most economical in the colder climates at least. When the art of air conditioning has been sufficiently developed, we may have mountain-top atmosphere in a veritable death-valley locality.

Detroit Turbine Accident Not Serious

Alexander Dow, president of the Detroit Edison Co., kindly furnishes our editor with the following particulars of the recent accident at one of his stations:

At 7:05 a. m. Tuesday, Nov. 26, the 45,000-kw. impulse turbine at Connors Creek Station, Detroit, which is the largest in the country in a single casing, began to vibrate seriously, shook the governor loose and went out of service in consequence. The vibration continued until the turbine had gone down below half speed. On opening the turbine it was found that four separate buckets, all of them in one-quarter of the circumference, had broken off the last, or twenty-first, wheel. These buckets going down into the condenser at high speed, had cut approximately 100 condenser tubes, which of course flooded the condenser and would have put the turbine out of commission had it not been shut down on account of vibration. The other damages are rubbing of labyrinth packing at each end of the shaft and of the knife-edge packing between stages, a natural result of vibration of the shaft due to unbalancing. The shaft may be slightly sprung, but the springing is not evident on first inspection, and at the time of writing a careful test was being made to determine this.

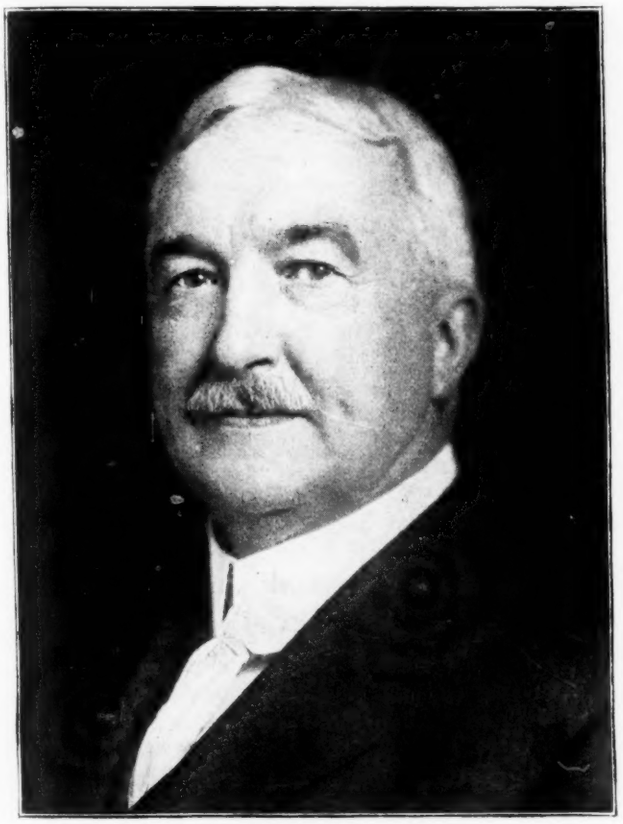
There was no external damage and no one was hurt, and excepting for a partial and temporary interruption of street-car service on the morning of the accident, there was no interference with business. The interference that did take place was not a direct consequence of the trouble with the large turbine, but was due to the behavior of one of the 20,000-kw. machines in the same station. This turbine had been given an overhauling after three years of service and had been finally closed up on the preceding day. The governor had not been tuned and was apparently quicker than the governors of the other turbines running on the system, which resulted in its picking up much more than its share of the load (25,000 kw.) that the large turbine was carrying at the time of the accident. This sudden increase of load, approximately a 50 per cent. overload, set the smaller turbine to vibrating and it had to be shut down and started again slowly before the vibration would stop. Opening the inspection handholes showed no apparent damage, and on starting up slowly it took its load. But the loss of the two turbines was enough to compel a reduction of service. The street car company, having its own plant and being quickly reached by telephone, was asked to pick up the necessary amount of load, but could not do so until certain changes of connections on the lines had been made to redistribute the work. Until these connections were made the street cars had to move slowly and some of them had to be cut off.

The boiler fireman is a big factor in steam-power plant economy, and his skill and intelligence may easily be worth more to the plant than his superiors' knowledge of the most economical point of cutoff.

New A. S. M. E. President

THE president elected at the 39th annual meeting of the American Society of Mechanical Engineers is Mortimer Elwyn Cooley. He was born in Canandaigua, N. Y., Mar. 28. 1855. He graduated from the United States Naval Academy in 1878; received an honorary M.E. from the University of Michigan in 1885; LL.D. from Michigan Agricultural College in 1907, and Eng.D. from University of Nebraska in 1911. On Dec. 25, 1879, he married Carolyn Elizabeth Moseley, of Fairport, N.Y. He has been a professor of mechanical engineering since 1881, dean of the College of Engineering since 1904, and dean of the College of Architecture since 1913, University of Michigan.

During 1879 Mr. Cooley was in the Navy and cruised in the Mediterranean and in 1880 on the Atlantic Coast;



MORTIMER ELWYN COOLEY

he was in the Bureau of Steam Engineering in 1881, and was Chief Engineer, U. S. N., 1898-99, serving on the U. S. S. "Yosemite" during the Spanish-American War. He was also chief engineering officer of the Michigan Naval Brigade from 1895 to 1911, and president of the Common Council of Ann Arbor Mich., from 1890 to 1901. He appraised the rolling stock and power plants of the Detroit street-railway systems in 1899; was in charge of the appraisal of the Michigan railways, telegraphs, telephones, etc., in 1900-01; assisted in the appraisal of the mechanical equipment of the Newfoundland railways in 1902; was consulting engineer of the Wisconsin railroad appraisal in 1903; had charge of the reappraisal of Michigan railways from 1903-5; was a member of the traction valuation committee of Chicago in 1906; appraised the Michigan telephone properties in 1907; in charge of the appraisal of hydro, steam and electric properties of the Michigan Railroad Commission in 1910 and 1911; special investigator of public-utility properties in Minneapolis, Milwaukee, Cleveland, St. Louis, Boston, New York, Sault Ste. Marie, Red Wing, Buffalo, Evansville, Washington, D. C., New Jersey, etc., since 1906; chairman of the Block Signal and Train Control Board of the Interstate Commerce Commission 1907-12; he was a member of the Engineering Commission of the Chicago Exposition in 1903; Commissioner on Awards of the Pan-American Exposition, as well as a Fellow of the American Association for the Advancement of Science and its vice president in 1898; member of the American Society of Civil Engineers and a director from 1913 to 1916; member of Franklin Institute; of the Society for the Promotion of Engineering Education and vice president of same from 1908 to 1909; Society of Naval Engineers; Michigan Engineering Society and its presiding officer in 1903; Detroit Engineering Society and the Sigma Phi, Tau Beta Pi and Sigma Xi fraternities. Mr. Cooley belongs to the Army and Navy Club of Washington and New York and the Yondotega of Detroit. His present address is Ann Arbor, Michigan.

The New Liberty Fuel

IN VIEW of the increasing demands for gasoline, not to mention the increasing price, any authentic information as to a more economical fuel is of widespread interest not only to the automobilist but to every machine-building firm using internal-combustion engines in any form. Unlike the stories that we have had of new fuels made by dropping some sort of a mysterious pill into water or some other equally inexpensive liquid, this fuel is made from kerosene as a base, as is the case with the gasoline now produced. Nor is it one of those accidents that sometimes occur, but a carefully studied method, the result of seven years' work by Edwin C. Weisgerber, Captain of Engineers in the Division of Research and Development. Captain Weisgerber was fortunately placed under the command of Maj. O. B. Zimmerman, who with his long experience in internal-combustion motors not only encouraged him in the face of opposition, but aided him materially by practical suggestions from the motor end.

The possibility of some such accomplishment has been pointed out by Bacon and Hamor under the heading of "Peroxided Kerosene," but it remained for the Engineering Division of the Army, in the person of Captain Weisgerber, to make the matter a reality. The great difference between this process and others is that this is a chemical method while the others now employed are mechanical, and the possibilities of a greatly increased supply of motor fuel at a greatly decreased price make the name Liberty particularly appropriate.

Over seven years ago Captain Weisgerber started work on the problem of finding a gasoline substitute, and his experience took him to various parts of the Globe. He had practically perfected the fuel before entering the Army, the additional research and tests giving it the finishing touches. The result is Liberty fuel, which, according to reports of the Division of Research Development, has the following characteristics:

The fuel is practically scentless and tasteless and the products of combustion are cooler than with gasoline, which reduces the amount of lubricant necessary as well as the problems of cooling. It is also noncorrosive and has a less deleterious effect on motors than gasoline.

It starts more easily than gasoline and will explode at a temperature below zero, this point being readily controlled in manufacture. It leaves no residue. The effect of the explosion is 30 per cent. greater than gasoline, but this as well as the quality and specific gravity can be controlled at will. It will not explode prematurely and ignites only from spark or flame.

It has been shown to give greater mileage in airplanes, automobiles, motorcycles, motor trucks and tractors. It can be made at much less cost than gasoline and uses as a base a product (kerosin) which can readily be obtained in any desired quantity. It can be substituted for gasoline for any purpose. It needs no special apparatus and no special engine or carburetor.

During the tests at the Naval Air Station at Anacostia, Liberty fuel was found much superior to the best gasoline, and with the motor running 1600 r.p.m. the water in the radiator never exceeded 160 deg. F. and the oil in the crankcase did not go above 130 deg. This quality of maintaining low temperature may help to solve some of the radiation problems of aviation engineers.

Those interested in the chemical details relating to the temperature of distillation can obtain them from the report of the Bureau of Standards, these tests having been made under the supervision of Dr. Dickinson, who has been in charge of the motor-development tests during the war. The fuel is obtained by distillation and the quality can be varied to suit the requirements of different industries.

There have been so many false alarms regarding the problem of fuel for internal-combustion motors that one hesitates to become euthusiastic over a question of this kind, but it seems that Major Zimmerman and Captain Weisgerber have succeeded in producing a new Liberty fuel. The need for such a fuel is beyond question and it is stated that arrangements have been completed for making it available in the near future.

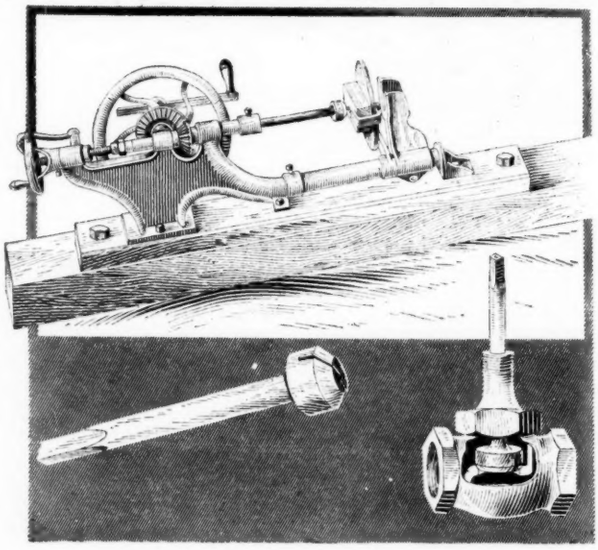
Reseating a Globe Valve

BY M. L. LOWREY

I was once sent to install an air compressor at a small gold mine in a remote part of the Sierra Nevada Mountains in east-central California. When it was set up and running, I remained a day to make sure that everything was all right. The owner of the mine, seeing that I had leisure time, asked me to look over the steam engine that furnished power for the small 10-stamp mill, as conditions were such that the mill could be shut down for a day.

Aside from the usual adjustments the engine was in fairly good order, but the 2½-in. globe throttle valve leaked so badly that it was necessary to close the stop valve at the boiler in order to stop the engine. The seat of this valve was in such bad condition that grinding was out of the question; apparently it had been twisted out of shape by carelessly screwing in the pipe.

As we were far from a machine shop, there was nothing to do but make a tool to machine the valve seat. The only machine at the mine was a small hand-power blacksmith's drill press, which was bolted to a post. This was taken down and secured to a timber in a horizontal position, as shown. One end of a piece of hardwood was cut down to fit into the drill chuck. A short block of wood, with a nail in it was clamped in proper position and made to do duty as a tailstock center. Then with a man turning the drill press, this piece of wood was turned with a hand tool, one end being slightly larger than the valve seat, and its face beveled to an angle of about 45 deg. The rest of the stick was turned to fit loosely in the hole in the valve bonnet. This was to guide the tool and hold it steady. These details are shown in the upper illustration. A piece of hacksaw blade was then fitted into the 45-deg. bevel and tightly wedged in place, and was ground down on a grindstone almost to the wood, so as to give but little clearance, to prevent chattering. The tool is shown at the lower



AN EMERGENCY VALVE-GRINDING TOOL

left side of the illustration. The application of the tool to a valve is shown at the other side.

The valve bonnet was then slipped on the shank of the tool and screwed into place. A lagscrew in the end of a piece of timber secured to the side of the mill furnished the feed, and by turning the tool with a wrench and feeding carefully with the lagscrew, the valve seat was soon machined in good shape.

Another short piece of wood was then held in the drill chuck and turned so the valve button would screw onto it, and with a man turning the drill press as before, the button was filed smooth, as it did not run true enough to turn it. A piece of emery cloth was burned on a shovel, and with the powdered emery thus obtained the valve was ground in the usual way.

We can never pay in full our debt of gratitude to our fighting men, but we can do much to show that we are not unmindful of what they have done. And the simplest, easiest way to do it is to obtain Red Cross membership during the Christmas roll call. There were a negligible number of slackers during the war. Let there be fewer now.

Change of Appliances

By Chesla C. Sherlock

THE common-law doctrine of assumption risk of a workman is comparatively well known to employers. This doctrine is nothing more than to say that if a workman enters upon the duties of a certain employment, he must be held to assume all the reasonable risks of that employment. The "reasonable" risks include those that are apparent to an ordinarily prudent person, such as defects of materials of machinery or other conditions coming vividly within the scope of the workman's employment. Employers make one mistake, however, and that is that they assume that a workman is held liable for *all* risks which are attached to his employment. This is not true. A workman assumes only the ordinary risks incident to his employment; he does not assume extraordinary risks or those which are unusual to the particular work which he is doing.

The various states have from time to time enacted statutes that materially affect these common-law rules and principles. For instance, we have the safety-appliance acts, the fire acts, factory acts, compensation acts, employer's liability and a number of other statutes which have so distorted and changed the situation in regard to the old rule of assumption of risks as to make it a considerably fogged matter for the casual observer.

Complexing situations are bound to arise in almost any shop, factory or power plant, which will bring up the question: What risks are assumed by the workmen and what are not?

Perhaps no more fruitful example of this situation could be given than that which arises in factories and power plants when there is a change of appliances or machinery going on. It is oftentimes necessary to put in a new belt or a new machine. Safety appliances will wear out or get out of working order from time to time, and it will be necessary to replace them. The employer is anxious to comply with the law in every particular, and as soon as it comes to his attention that a safety appliance is no longer adequate or that a certain machine is in a defective condition, he orders the defective part replaced. But does it occur to him that while this process of change of appliances is going on his legal liability has doubled and trebled in intensity?

This is due to the fact that the courts have said that a workman cannot be held to have assumed the extraordinary risks of the employment and a change of machinery or of appliances has been held to create an extraordinary risk in the employment. Labatt, speaking of this subject, said:

> Most of the cases in which the servant's nonassumption of risk is asserted, relate to injuries caused by dangerous conditions that arise from or are incident to the intrinsic quality or the permanent arrangement and relative disposition of the instrumentalities of the business or the materials which the servant is required to handle.

In a Federal case the plaintiff had been working in a roundhouse. It was shown that the lighting facilities were very poor and had been during the entire period of the plaintiff's employment. At the time of the injury the plaintiff was riding on the outside of an engine that was slightly larger than the others he had been working on. In passing a post set between the tracks, he was brushed off because of the extraordinary width of the new engine and received the injuries complained of. It was shown that the plaintiff had not been advised of the danger of riding on the outside of this engine and that he did not know that it was larger. In its decision, the court said:

> Under the rule that the employee assumes all the ordinary risks of his employment, it may be said the plaintiff assumed the risks incident to working without artificial lights, so long as the instruments with which he labored remained the same or so long as he was fully advised of any alterations or changes that enhanced his danger. A servant does not assume extraordinary or unusual risks of his employment.

The authorities are well agreed that an employee cannot shut his eyes to the obvious dangers of his employment, even though they were created through the negligence of the master. He must exercise his prudence at all times, and must be held to assume such risks as are incident to his employment. If something of an unusual nature arises, of which he cannot acquaint himself by mere observation, then he is relieved from responsibility. Says one authority:

> When an employee first undertakes dangerous work, there rests upon him the duty of using his senses to protect himself, but it is only natural that an employee should, after a time, become so accustomed to the danger that he unconsciously guards himself from it. If, however, the danger is without warning, increased by a positive act of the master, the employee is not prepared for the added risk, and it would seem clear that there is a duty resting upon the master in cases of this character, to inform the employee of the change; and the omission to give this information is negligence, the risk of which is not assumed by the employee.

The Federal court, in the case mentioned before, stated the matter very clearly: "A most cautious person might have been lulled into a feeling of security from having repeatedly made the same trip with apparently the same means, without injury." In an Illinois case, it was held regarding factory employees as follows:

> Employees of a factory do not assume the risk arising from the negligent conduct of the proprietors of the factory who, in shifting an engine in the engine room, projected an unguarded shaft thereof into the working room of the factory a greater length than was necessary and failed to cut it off because of the press of business. The shifting was made at night, but the employees knew of the change. It was because of the fact that it was a temporary peril to which the employees were exposed by the negligent conduct of the proprietors of the factory that they were held not to have assumed the risk incident thereto. It is further stated that under the circumstances of the case the injured employee was under no legal obligation to give notice to the proprietors of the temporary peril to which he was exposed, and demand its removal, before he could maintain an action for injuries; and there may be cases in which such notice must be given, and if not removed, the employee must quit the employment or assume all of the hazards, but this is not such a case; for here the danger was created by a positive act of the proprietors of the factory. There is neither reason nor authority for such that notice is necessary in such a case.

The duty of the employer where a change of machinery or appliances is taking place is very clear and well defined at law. Under the common law he is bound to exercise the greatest care and fully warn his employees of the extent of the increased risk in their employment.

Under the workmen's-compensation acts the rule of assumption of risk is abolished, and those employers operating under the compensation acts cannot raise it as a defense. Under these acts the court does not care how a workman was injured so long as it can be shown that he was injured in the course of his employment for the employer.

Consequently, the liability of the employer is practically the same in either case, whether he be under the common law or under the compensation acts.

Remember the Red Cross Christmas Roll Call

The ending of the war does not lessen our obligations to our millions of soldiers and sailors. We are in duty bound to look to their comfort and well-being, and the means through which this end can best be attained is the Red Cross. It has organization, experience and universal confidence.

It is aiming for universal membership. It is asking that every American in the land enroll under its banner. What time could be more fitting than the days preceding Christmas, when the whole world is moved by the spirit of benevolence and Christian charity?

Universal membership means more than money. It means the whole-hearted moral support of the people at home and expresses their belief in the value of Red Cross work. It gives everyone a personal and a vital interest in the welfare of those to whom we owe the safety and security of our lives and of the nation.

EDITORIALS

Possibilities in the Power Field

PRESIDENT Charles T. Main, of the American Society of Mechanical Engineers, in his address upon "Broader Opportunities for the Engineer," devoted a number of pages to the generation and distribution of power. After referring to the work of engineers in conserving fuel during the war, he said:

"Considerable savings in fuel have been effected recently by more careful attention to the burning of fuel and the use of steam in prime movers, but much more has been saved in simple commonplace and commonsense ways of preventing the waste of heat and power after it has been delivered from the boiler and engine rooms to the various departments about the plant."

"Much of the coal shortage had been caused by lack of transportation and one-fourth of all the coal hauled was used by the railroads that hauled it. Much of this traffic could be eliminated by the establishment of large steam-generating plants near the mines, by the development of hydro-electric powers and by the electrification of the railroads.

"Savings can be made by more careful study and use of the waste heat of furnaces in the form of gas for the production of power and from steam turbines and engines by the use of steam and warm water for heating and manufacturing purposes.

"The interconnecting of hydro-electric stations, the redevelopment of many of the older water-power plants and the conservation of flood waters are mentioned as further sources of saving.

"The four chief reasons why this sort of development has not proceeded more rapidly are that the development expense and yearly charges of many would be so great that the returns would be insufficient to offset them and show a fair return on the investment, the inability of parties at interest to agree on some working plan for sharing the expense, that legislation has been of a discouraging nature, and because in the past all values have been measured in dollars and cents, as applied to the cost of power, with not much consideration to conservation or the uses to which the power was put.

"From now on we should consider the value of development with a broader conception of not only the net comparative cost of power, as produced by one means or another, but also in connection with the desirability of having another instrument by which the full production is assured, the value of the product being far greater in most cases than the cost of power, and with the desire to conserve our natural resources, and with a view in times of shortage, of assisting in the general stabilization of business."

He emphasizes the broader view which should be taken of the subject of conservation not as a problem by itself, to be decided in terms of money as applied to that particular problem, but with careful consideration of the broader bearing upon the greatest good for the community or the country.

A Suggestion

THE war and all that it precipitated brought home the fact that not only were we in America a more illiterate people than we imagined ourselves to be, but that to be thoroughly successful in the conquest for trade that will be part of the reconstruction program, the workers in the engineering industry particularly must be provided with means for bettering their technical education. How thoroughly England has realized these conditions as they apply to herself is demonstrated by the passage of the education bill, which is one of the most comprehensive measures of its kind ever passed by a legislature. It is certainly the broadest educational program, industrially, ever entered upon by any people.

The activities in this direction recall to mind the Institute of Operating Engineers, now defunct. The chief thought underlying the organization and purpose of the Institute was the creation of a sort of classroom in each power plant, the chief engineer or other competent man being obligated to act as an instructor to the men under him to the end that not only would the plant gain because of the better understanding of it that such study would produce on the part of the men operating it, but every power plant in the community would greatly profit thereby. The Institute became defunct not because of any weakness in the prime reason for its organization. That is just as strong today; in fact, it is stronger than it ever was. It is unfortunate that the idea is not made use of. Certainly, there seems every reason to believe that the few large organizations of power-plant engineers could apply this idea and not only gain greatly in membership, but render the country a worth while service.

Central-Station Service or Isolated Plants for the Industries

AT THE recent annual meeting of the American Society of Mechanical Engineers W. F. Uhl presented a paper under the title, "Industrial Power Problems," which considered the vexed question of central-station service versus isolated plant upon a broad engineering basis, free from the acrimony and self-interestedness that have characterized so many utterances upon the subject. The cost of power is so small an item in the total cost of conducting the average industrial establishment that it may easily be exceeded by the losses incurred by irregular and interrupted production. When equally reliable power can be bought as cheaply as it can be produced, it is better to use it and put all the available capital, attention and energy of the concern into its product instead of encumbering it with a power department, and if the station from which the power is purchased is relatively large and has a fair load factor, this would tend toward fuel conservation.

The possession of a water power and the demand for

exhaust steam or hot water are important factors in determining the cost of power and whether it can be made cheaper than it can be bought. Where an industry requires considerable heat for manufacturing processes and warming buildings, power can generally be made cheaper than it can be purchased and fuel would be conserved by making it.

Between these two extremes there is a wide variety of situations, each demanding analysis, and the author considers them impartially as affected by the assumed conditions.

This is the spirit in which the problem should be attacked. The power supply of an industry is an engineering problem, and an engineer who has nothing but his reputation at stake, who is not interested in the sale of current or of power-plant apparatus, can determine, in any case in which there is a degree of difference worth considering, whether it is better to run a power plant or to purchase current. Where there is not difference enough to be determined positively by such a study, it will not matter much which course is pursued.

A field, the potentialities of which have been lately discussed, is touched upon by the author in his suggestion of the possibility of financial gain for both central plant and industry by the operation of isolated plants by the public-service interests. The collective operation of a number of plants would give all the advantages of diversified demand, reserve capacity, feasibility of operation at high efficiency and the greatest possible use of exhaust steam.

Preventing Clinkering of Furnace Walls

IN THE ordinary boiler furnace in which the fires are not forced, the formation of clinkers does not interfere with the furnace lining to any extent, but when the furnace is driven hard and a high temperature is maintained there will be more or less trouble with a growth on the side and bridge-walls. Naturally, this trouble occurs along the fire line, and when an attempt is made to break the clinker accumulation loose, it is likely that the brickwork will be more or less damaged. If the bricks are not loosened, their faces will, in most instances, be chipped away, and they will eventually have to be replaced.

As clinkers are formed by the fusing of ash into a slag when exposed to high furnace temperature, it is logical to assume that the slag formation would be prevented if some means could be used to keep the ashes comparatively cool. Some years ago a system was devised whereby air was supplied to the furnace along the fire line through pipes placed in the brickwork of both the side walls and also in the front of the bridge-wall. Since then similar methods have been used, such as openings between the brick furnace lining or holes in specially formed bricks or blocks through which the air enters the furnace from an air chamber in the boiler setting.

Air entering the furnace through these openings will absorb heat from the brickwork along the fire line, and this will of course cool the bricks, and the tendency of clinkers to adhere to them will diminish with the reduced temperature. If enough air is admitted, the trouble from clinker-lined sides and bridge-wall should be practically eliminated.

It might justly be assumed that the admission of excess air at the side and rear of the fuel bed would be detrimental to the furnace efficiency, but as the supply can be controlled by a damper and as combustion is assisted by an excess of air directly after firing, it would appear that the admission of air by this means would be beneficial to combustion provided the air damper was properly handled by the fireman in charge.

Red Cross Christmas Roll Call

BEGINNING on the sixteenth of December the Red Cross launched a campaign for universal membership—that is, the enrollment of all persons in the United States as members of that organization—the membership dues being one dollar a year. The campaign, which will continue until December 23, deserves the recognition and unstinted support of every citizen.

It is superfluous to recount the achievements of the Red Cross during the time of active hostilities. The extent of its ministrations, the suffering it alleviated, the hardships and difficulties it overcame, the countless heroisms it displayed—these are matters of history. But though the carnage is ended, there is no cessation of demands upon the Red Cross.

The period of rehabilitation and reconstruction presents new opportunities for service to humanity and the Red Cross is quick to see and to seize these opportunities. Among the important phases of its future efforts is the refitting of crippled and disabled soldiers for useful and remunerative employment in various trades. Such work as this should stir everyone to generous impulses.

When the Christmas roll call is completed, let the report be "All present or accounted for!"

Recently, the large power plants of the Public Service Corporation of New Jersey have been running at what might be termed a peak load during the twenty-four hours of the day. New York plants, on the other hand, have had a surplus, and it has been suggested by the War Industries Board that electrical energy be taken from New York to New Jersey. It might be a good idea for other competing companies in various parts of the country to get together in relieving the power situation in like manner.

Reports from the Fuel Administration show that out of seven hundred and six mines one hundred and sixty-one were improperly preparing their coal. A heavy fine or imprisonment for the offenders for each offense might be a healthy procedure. There are different kinds of thiefs, but one is as bad as another, and all should be regarded as criminal.

Public and private construction work in Chicago suspended during the war, and to be resumed during the coming year, is estimated at one hundred and ninety-seven million dollars. This does not look like business stagnation as an after-the-war prospect.

In spite of the degree to which women have invaded the industrial field, few of them seem to have become firemen or engineers; so we shall be spared the trouble of readjustment in that quarter at least.

CORRESPONDENCE

In these and other columns "Power" wants to tell how you have decreased the fuel consumption in your plant. Since the fuel shortage, engineers have been thinking hard about conserving fuel. Thousands have made changes in equipment, in operating methods, and in modifications to boiler settings, etc., all of which have, in many plants, greatly cut fuel consumption. You owe it to the country to tell your fellow-engineers how you have saved coal. "Power" will pay for good articles that will help the other fellow save coal as you have saved it. Engineers must save at least 35 million tons this year. Let's have your story.

Methods of Testing Lubricants

I read with interest Prof. Trinks' letter on page 644 in the issue of Nov. 29 concerning the lack of practical methods for ascertaining the value of different lubricants.

Lubricants are used for the purpose of reducing the friction and wear of moving machinery. Friction results in the loss of useful power. Such abnormal friction may take place in engine cylinders and other moving parts that they may become burned, cut and grooved, although, in my experience, nine-tenths of the grooving and cutting comes from other causes than lack of sufficient oil or the use of an oil of poor quality. That oil reduces friction can be easily demonstrated, and tests throwing some light on the values of different lubricants can be made in various ways by any engineer having a little ingenuity and considerable patience. One or two ways are suggested in the following:

Discontinue for a few hours the use of any lubricant in the cylinder of an ordinary steam pump which has its speed controlled by a throttle valve, then note the pressure the pump is working against and the pressure of the steam, below the throttle, necessary to operate it. Having noted these conditions, admit cylinder oil to the valves and cylinder through the "tallow cups." At once, without changing the flow of steam by the throttle valve, the speed of the pump will be increased from 10 to 50 per cent. A record should also be made of the length of time before the speed of the pump falls to what it was before the oil was admitted. Many other experiments as to time and quantity, with different other oils, will suggest themselves and can be tried without injury to the pump. Nearly every engineer will recall occasions when he has failed to lubricate the cylinder of a pump for a considerable time, then admitting oil, has had to adjust the throttle valve so that the pump did not "run away."

Tests of engine or bearing oils can be made by selecting a generator or some other machine that has a constant load, preferably one in which the bearings run in a bath of oil. Fill the bearings with the oil to be tested and insert therein an ordinary dairy thermometer containing colored alcohol so that it can be easily read. Take a reading from the thermometer every half-hour and see that the power being developed by the machine is as nearly constant as possible. Paradoxical as it may seem, in some instances the temperature of the new oil may at first go higher than the oil that has just been removed even though it all came from the same barrel. For that reason the test should be continued for at least 36 hours. Other things being equal, the oil that holds the bearing at the lowest temperature is the best lubricant.

In almost every plant there is some engine, pump or machine upon which, without danger of injury, the engineer can make tests that will satisfy him as to the value of any lubricant. That fact having been ascertained, it then becomes a question of price, although it should be borne in mind that the lubricant which will reduce friction to a minimum is usually the cheapest to use.

CHARLES H. GARLICK.

Pittsburgh, Penn.

Observations of a Boiler Inspector

Following are some conditions found while inspecting boilers in the State of New York. When a boiler inspector goes to a plant to make an investigation, to see that the boiler has been inspected regularly, he is often told that boiler inspection is a farce, that all it amounts to is a waste of time and so on. If the inspector tries to explain that boilers if not properly cared for are likely to be dangerous, the reply will be that he has never had an accident and therefore does not consider an inspection necessary.

Going into a cheese factory plant a few days ago, I found there was no water in the gage glass. I called the operator's attention to the fact, and he stated that he had very little knowledge about boilers and did not know that water must be kept in the glass. This operator had never been around boilers at all before. Questioned about various safety devices, he could not tell what they were or what they were for. There are numerous cases like this and I therefore believe that a law should be enacted requiring that each operator or attendant must know the principles of safe boiler operation.

In another plant, also located in the country and not subject to the same ordinances that plants operated in the cities are, I found the water gage-glass broken and the gage-cocks absolutely useless, as the handles and valve stems were broken off. Still such owner will tell you that inspection is unnecessary. I once saw a boiler of the locomotive type from which numerous stays had been removed and common gas-pipe plugs screwed in their place. The sheets were as thin as tissue paper in numerous places, yet the boiler was carrying upward of 90 lb. steam pressure. It was a wonder that it did not explode.

By the present New York State law only boilers used in factories, mines, tunnels or quarries are subject to

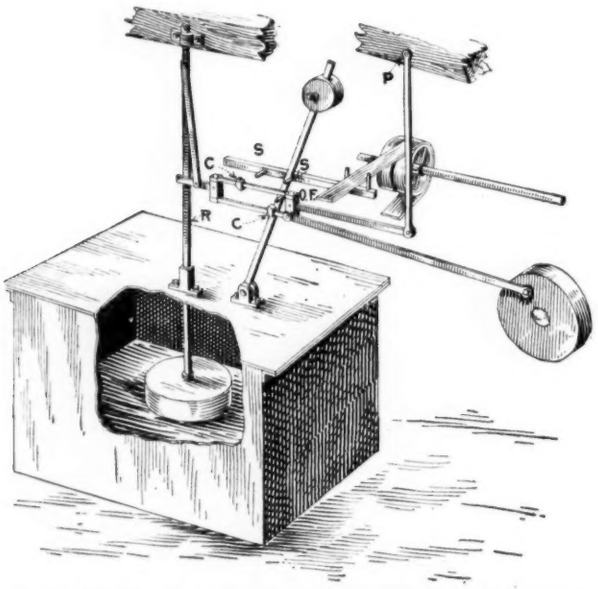
inspection, but I hope the time will soon come when the law will be extended to include boilers carrying 15 lb. pressure or over, for any purpose whatsoever. I know of portable boilers and others, operated by incompetent individuals, that are in an extremely dangerous condition, yet they are not by the present law required to be inspected.

C. C. WHITE.

Olean, N. Y.

Belt-Driven Pump Regulator

When labor is scarce and a man is compelled to assume duties which ordinarily would be divided among several persons, the development and adoption of labor-saving devices is commendable both as a business and as a patriotic need. Several years ago I devised a rig to control a power-driven well pump supplying



BELT SHIFTS TO LOOSE PULLEY WHEN TANK FILLS

water to a small tank, and as the capacity of the pump was considerably greater than the requirements of the boiler it required pretty close attention to prevent the tank either going dry or running over. The apparatus shown in the illustration was developed and gave excellent service.

The pump was driven by means of a belt over tight and loose pulleys so the control was designed to shift the belt at the proper time to keep the water in the tank within about six inches of a certain level at all times. There is a float in the tank connected to a vertical rod, which is well guided vertically and which carries at its upper end a swinging connection to the free end of an oscillating frame *OF*. This swinging frame is carried at its other extremity by a hanging link suspended from the pivot *P*. There is also a connection from the swinging frame to the revolving crank, as shown, the crank having a speed of five to ten revolutions per minute (the exact speed is immaterial, but it should be pretty slow). This swinging frame carries two adjustable lugs *C* to come in contact with a pin on the shift lever at the proper time. This shift lever, carrying at its upper end an adjustable weight, comes in contact with either of the pins *S* on the shifter bar and causes the shifter to change the belt from one pulley to the other.

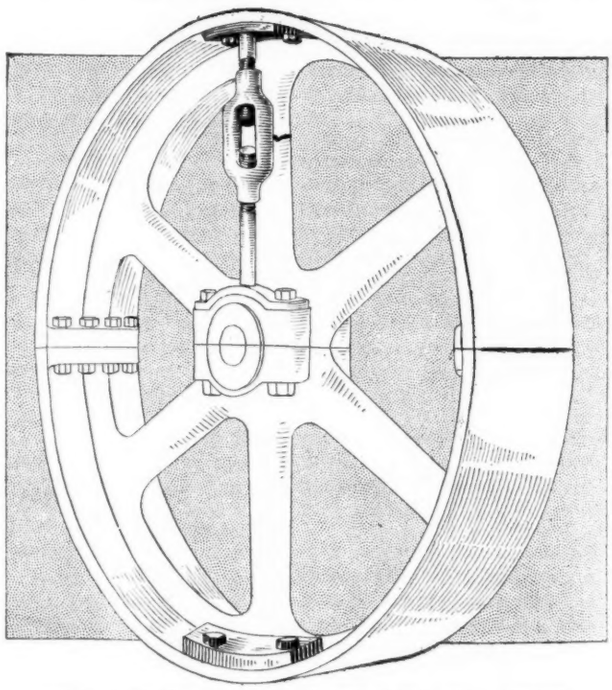
With the pump in operation and as the water level reaches a certain point, the swinging frame will be raised enough to throw the shift lever to the left thereby moving the belt to the loose pulley; and as the water level lowers, the operation will be reversed by reason of the other lug striking the shift pin, and the pump will again be put in operation. I have given no dimensions because each plant would probably require a little different design. In actual service this apparatus works well and is a great trouble saver. In designing it a few points should be kept in mind: The pins on the shifter bar should be far enough apart so that the lever will pass the center a short distance in going from one to the other; the swinging frame should be long enough so that there may be some over-travel without the ends of the frame hitting the shift pin; also if the faces of the lugs are slightly hollowed where they strike the pin, it is better than leaving them flat.

EDWIN KILBURN.

Bremerton, Wash.

Broken Spoke Reinforced

Some time ago an oiler in wiping a flywheel on one of our steam-driven exciters noticed a crack in it. The chief was afraid to run it in this condition, so reinforced it as shown in the illustration. One end of a 1-in



TURNBUCKLE ROD HOLDS THE RIM OF A WHEEL

turnbuckle rod was welded to a strap $\frac{5}{8}$ in. thick and 8 in. long formed to fit the inside of the rim and bolted on. The other end of the rod was welded to another strap of the same thickness formed to the hub and long enough to reach under the hub bolts. A strap of iron was fastened to the rim on the opposite side of the wheel to act as a counterbalance. The engine has been in operation since and the crack has not increased.

Norristown, Penn. WILLIAM H. WATSON.

Should Boilermakers Be Licensed?

In many localities plumbers are compelled to undergo examination and secure a license. This is intended to insure sanitary and reliable workmanship. Marine engineers, and in many places stationary engineers and boiler inspectors, are examined and licensed, all intended to make for the safety of life and property. Why not examine boilermakers? Their work is very important and much depends upon their skill and knowledge of the work and the manner in which it is done. In the annals of "Power Plant Criminology," in section "Boiler Butchery," there are many cases of malpractice on steam boilers, and bad practices still exist in many places. In twenty years' engineering experience I have seen and heard of many questionable repair jobs.

Many boilers have patches on the front course where a slight depression had developed, which might have been heated and driven up at a little cost, making the boiler less likely to give future trouble than if patched. Small double-riveted patches have been found, placed directly over the fire on return-tubular boilers, and also the other extreme, half-sheets of considerable length having the longitudinal seams single-riveted and of low efficiency, thereby causing the working pressure of the boiler to be reduced, or the boiler operated with a small margin of safety.

In a small grist mill the back head of the return-tubular boiler had become corroded by leakage from the handhole, and a boilermaker was called to make repairs. While taking the measurements for the patch he learned that the boiler was sixteen years old and advised the miller that it was time to have it retubed. He did not look inside of the boiler, but said that if it was sixteen years old the tubes should be renewed on account of their age. About that time a sales engineer happened along and, being consulted, recommended securing the services of a competent boiler inspector to determine the condition of the tubes. An inspector was engaged and reported that the tubes were in good condition since the boiler had never been fired hard or abused in any manner and the feed water was of the finest quality. There was only a slight powdery deposit on the inner surfaces, and no evidence of any corrosion could be found. Externally the tube ends were as fine as the day they were put in, all being carefully beaded and not a broken bead or evidence of a tube ever having been rerolled. The tubes are still in the boiler.

A half-circle patch of $\frac{11}{32}$ plate drilled with $\frac{15}{16}$ holes was put on a return-tubular boiler that was in a country place where hand riveting was necessary, although the boilermakers were from a large city. The foreman on the job, being asked why they were using such large rivets, replied that they "mostly used that size on repair work." How much easier and better it would have been to drill the proper-sized holes and to drive rivets suited to the plate used. Many such cases could be quoted by traveling engineers.

My attention was recently called to a boiler nearly thirty years old, which had developed a crack along the longitudinal seam. Boilermakers cut out a proportion of the fractured plate and put on a patch, but when the insurance inspector came he ordered the boiler out of service and also several others in the same plant that were of the like type and age. The owners desired to continue the use of the boilers, but following the boiler regulations for the commonwealth the Bureau of Inspection refused permission to operate them again. Repairing boilers in this manner, after they have given warning of their dangerous condition, might be classed as criminal negligence.

It would be "good business" to teach the boilermakers the safe and sane way to repair boilers, and above all, when to refuse to make repairs. The owners of steam boilers may be excused for not knowing the rules and regulations relating to repairs. Far from intending this to be a knock at the boilermaker, it is intended to bring about if possible a better understanding of the whys and wherefores of boiler repairs. It is well known that general boiler work has been much improved in recent years, and the boiler manufacturer or boilermaker who has kept pace with the march of progress would not be worried if obliged to stand an examination for a license. The men who would be compelled to study and investigate before examination would be much benefited. Engineers' license laws have not been credited with mending the morals of men or curing "hookworm," but have caused many engineers and boiler inspectors to study and learn details of their business which they would never have troubled themselves about under other conditions.

If boilermakers were examined and licensed, would boiler work be improved? Would boilers be made safer by being properly repaired? Would some of the unsafe and unnecessary repairs now made be eliminated?

Pittsburgh, Penn. J. A. SAWYER.

Alternating-Current Motor on an Air Compressor

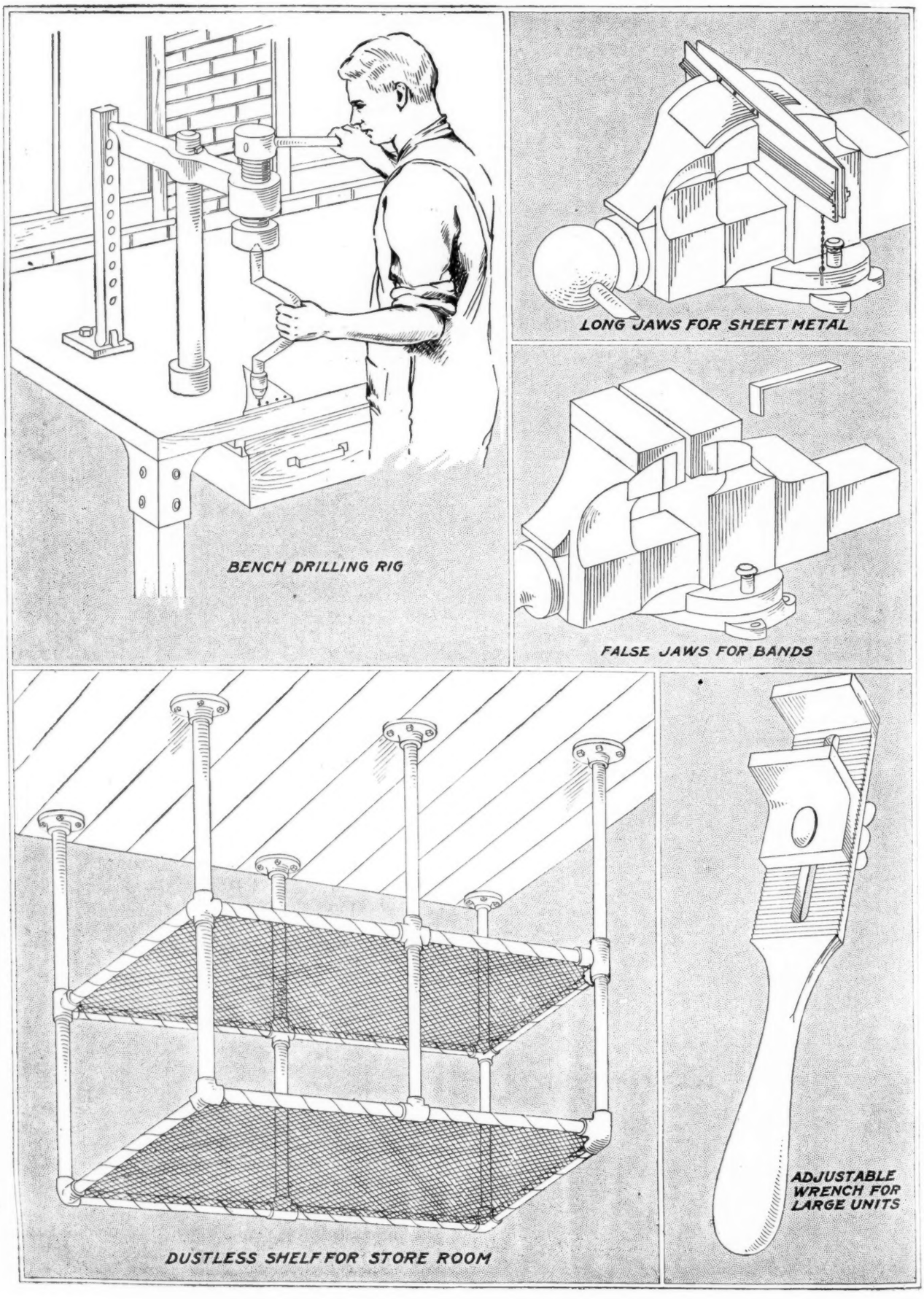
A stone cutter, who used considerable compressed air for pneumatic hammers, had the compressor overhauled and a new automatic starter for the electric motor installed. The motor was a single-phase 220-volt self-starting squirrel-cage clutch type, belted to the compressor. In this type of motor when the circuit is closed the rotor starts to revolve, and when it has attained sufficient speed the clutch takes hold and starts the compressor. When tried for the first time the motor started, but when the clutch took hold the motor stalled because the compressor would not start. Several men tried to help by turning the flywheel, but without success, and unless the man operating the switch was very careful the fuses would blow.

As the starting box was the only new part (the motor having driven the compressor for over two years previously), naturally it was thought to be the cause of the trouble. An ammeter and voltmeter were connected in the circuit and showed the motor to be overloaded when starting, but after the compressor was started the motor was well able to carry its load.

A clicking noise heard at the back of the compressor proved to be coming from the unloading device, supposed to prevent the air pressure from rising in the compressor until the motor was at full speed, but it was not working properly. After this device was oiled and adjusted, the motor started easily every time.

New York City. A. RATHRON.

Ideas for the Power-Plant Engineer


BENCH DRILLING RIG
LONG JAWS FOR SHEET METAL
FALSE JAWS FOR BANDS
DUSTLESS SHELF FOR STORE ROOM
ADJUSTABLE WRENCH FOR LARGE UNITS

Inquiries of General Interest

Keep Oil Out of Boilers—Would it be injurious to a water-tube boiler to add a small amount of fuel oil to the feed water for loosening scale? W. C. M.

Mineral oils, especially the heavier grades like fuel oils, when introduced into boilers are likely to form tarry deposits that are difficult to remove by ordinary cleaning processes. When such deposits form on heating surfaces near the fire, they may cause rupture of the boiler material from burning out or bagging. Many boiler failures with serious results have been traced to this cause, so that by the use of oil for prevention or removal of scale the effect of the medicine may be worse than the disease.

Advantages of Pressure Regulator for Steam Heating.—When heating coils are supplied direct from a high-pressure boiler, should a reducing valve be used, or should the steam be supplied at full boiler pressure? A. P.

Heating coils should be supplied with steam at no higher pressure than required to secure circulation and sufficient temperature. Higher pressure is unnecessarily dangerous and is likely to cause interference in circulation of radiators that are connected on the same return line, and results in waste of steam at air valves, traps or other vents employed to obtain circulation. Hence for a steam-heating system, where the boiler pressure cannot be reduced to the requirements, the supply of steam should be taken through an automatic pressure reducing and regulating valve to insure better operation and greater safety and economy.

Use of Differential Draft Gage—In using a differential draft gage that is provided with two outlets, how would the gage be connected? W. T. G.

The gage shows the difference of pressure in the outlets. The outlet at the zero end is to be connected with the place where there is greater pressure. For instance, in determining the loss of draft through the grate and fuel bed, the outlet at the zero end of the scale would be connected with the ashpit and the other outlet would be connected with a pipe projected into the furnace over the fire. For determining the loss of draft through the flues of a return-tubular boiler, the zero end would be connected with the rear combustion space and the other end with the front smoke connection. For determining the force of the chimney draft, the outlet at the zero end of the gage would be connected with the atmosphere and the other outlet would be connected with the chimney flue.

Best Amount of Compression Depends on Conditions—How much lead and how many inches of compression would be suitable for a 22 x 42-in. single-eccentric Corliss engine running 100 r.p.m.? P. H.

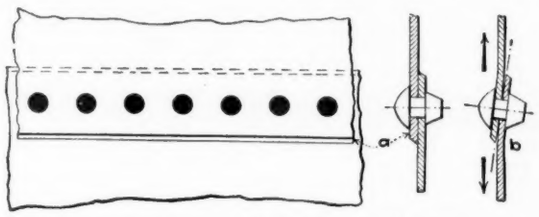
About $\frac{1}{32}$ in. lead should be sufficient to insure good admission. Sufficient compression of exhaust is to be obtained to fill the clearance space with exhaust compressed nearly to admission pressure and thereby prevent waste of initial steam for that purpose, and to secure smooth running of the engine by cushioning on the exhaust in overcoming the inertia of the piston, piston rod, crosshead and connecting-rod. The fraction of stroke necessary to compress the exhaust to a given pressure depends on the amount of back pressure at the beginning of compression and the percentage of cylinder-clearance space, while the cushioning effect required for smooth running depends on the amount and distribution of forward pressure on the piston, amount of running clearance of crank and crosshead pins, the weight of reciprocating parts attached to the piston, length of stroke and number of revolutions per minute. Hence the number of inches of compression required depends on the design and running conditions. For a 22 x 42-in. Corliss engine making 100 r.p.m. under ordinary running conditions, and exhausting against 2 to 4 lb. back pressure, about 5 inches of compression would be suitable.

More Heat Obtainable from Exhaust When It Is Dry—In a plant equipped with throttling-governor high-speed engines, driving fans for a ventilating and indirect heating apparatus, the exhaust steam is employed for heating the stacks, and in coldest weather this is supplemented with live steam supplied through a reducing valve. The engines run at proper speed when supplied with steam at 40 lb. boiler pressure, but the boilers are capable of carrying a working pressure of 80 lb. Would there be any economy of operating with 40 lb. boiler pressure during mild weather or at times when the whole of the exhaust is not required for the heating? A. F.

When steam is wiredrawn, as by passage through a throttling governor for reduction to the pressure required for maintaining the proper speed of an engine, the higher the initial pressure the higher will be the quality or percentage of dryness of the steam supplied to the cylinder. For the same load on the engine the heat converted into energy is the same, regardless of the quality of the steam, but the lower the quality the greater the loss of heat from cylinder condensation and the larger the proportion of heat contained in the condensate discharged with the exhaust. As the heat contained in the water is not recoverable for ordinary exhaust steam heating, greater economy would be derived from steam supplied to the engines at the higher pressure.

Superiority of Butt and Double-Strap over Lap Joint—Why is a butt and double-strap joint better than a lap joint for the longitudinal seam of a boiler shell? D. W.

In a plain lap joint such as illustrated, the plates are eccentric to each other, and as the stress pulling across the joint has a tendency to bring the plates into line, the joint originally as at *a* assumes or tends to assume the distorted form shown at *b*. This action may be relieved by



DISTORTION OF LAP JOINT FROM STRESS

bending the plates before they are riveted, but the rivets then are exposed to considerable tension as well as shearing stress. In either case the bending action is likely to open the laps and leakage and cracks are likely to occur where the distortion is most severe. There is the same tendency to distortion with double-riveted laps although not to the same extent, when bent before riveting, as the greater width of joint makes preliminary alignment of the plates possible without sharp bends. But so many boiler failures have been traced to cracks and excessive stresses at the laps that, in good practice, this type of joint has come to be regarded as unfit for longitudinal seams of high-pressure boilers. In a butt and double-strap joint the plates to be joined lie in line with one another, the joint is built up nearly symmetrical by inside and outside cover plates and there is little or no tendency to distortion and cracking of the plates.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for inquiries to receive attention.—EDITOR.]

The Low-Temperature Compression System in Practice*

By H. SLOAN

At the annual meeting of the society in 1916 the low-temperature compression system was described and the methods by which economical results could be obtained were explained. During the present year three different installations have been put in operation, which have been successful from the start. All are operated in connection with brine cooling systems.

The first equipment, which was installed at the plant of the Central Cold Storage Co., Chicago, Ill., consisted of two-stage compressors, rated at 250 tons refrigeration per 24 hours. There were two of these compressors, 28 and 20½ x 48-in. stroke, driven by cross-compound condensing engines, 20 and 42 x 48-in., with poppet-valve high-pressure cylinders and Corliss-valve low-pressure cylinders. The engines were designed to operate with steam at 160 lb., gage, 100 deg. superheat and a vacuum of 26 in. The rated speed for the compressors was 57 revolutions per minute.

The cooling and filling of the storage rooms commenced in July, and from the start a brine temperature of —20

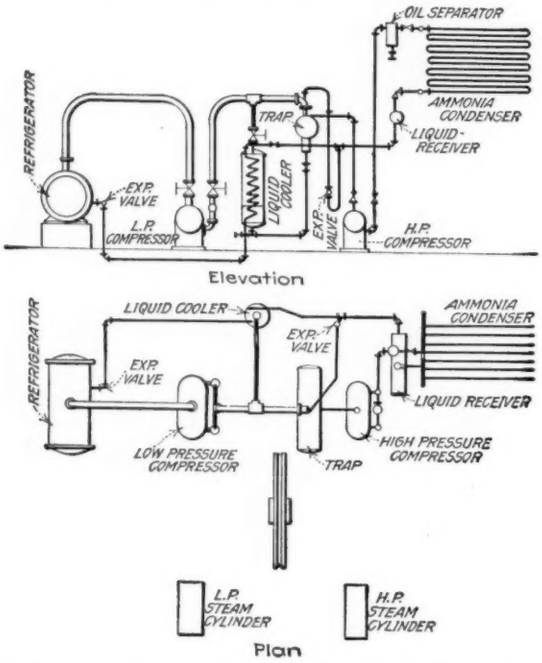


FIG. 1. ELEVATION AND PLAN OF LOW-TEMPERATURE COMPRESSION SYSTEM

deg. was easily maintained, having a range of about 6 deg. F. During the last week in July the daily average for goods placed in storage was 245 tons, and it was never necessary to operate more than one machine and at an average of not over 40 r.p.m. to maintain the required temperatures. One temperature brine is circulated and variable room temperatures are obtained by proportioning the pipe and regulating the control valves. The building contains approximately 4,424,000 cu.ft. and the cold-storage rooms 3,000,000 cu.ft. Provided the machine was operating at its rated capacity of 250 tons, then 12,000 cu.ft. of space was refrigerated per ton of refrigeration. The room temperatures range from 35 deg. to 29 deg. F. for the first eight floors and those above are sharp freezers where temperatures from 0 deg. to —15 deg. F. are maintained. The twelfth and thirteenth floors are arranged for beef freezing.

The average coal consumption during July and August was slightly over 12 tons per day, which included that used for the electric generator supplying power for lighting, elevator service and the entire power requirements of the building.

The second two-stage installation to be placed in operation was at the plant of the Beatrice Creamery Co., Chicago, Ill. Here the equipment consisted of two low-temperature compression machines, each having a rated capacity of 200 tons refrigeration per day. The compressors are 19 and 24 x 48-in. stroke, driven by cross-compound engines 20 and 40 x 48 in. In addition to the low-temperature machines, one duplex 17½ x 34-in. compressor is provided for high-temperature work, which is driven by a cross-compound condensing engine 20 and 40 x 34-in. stroke. All the engines have poppet-valve cylinders for the high pressure and Corliss valve gear on the low-pressure cylinders. In this plant the gas from the low-pressure ammonia cylinders is discharged in a long header, where it is cooled to the saturation point of the pressure corresponding to the intermediate pressure or the suction pressure of the high-pressure ammonia cylinders. This header also acts as a suction drum for the 17½ x 34-in. duplex compressor. This low-temperature system, like that in the Central Cold Storage Co. plant, was started without difficulty and has given satisfactory results.

In the low-temperature machine the gas is cooled after leaving the low-pressure cylinder by the injection of liquid ammonia. The excess liquid, separated in the intermediate drum, trails down to the liquid-ammonia cooler by gravity, and cools the liquid while passing through the coils of the cooler. The liquid-ammonia cooler is located between the condenser and the brine coolers. The gas evaporated in the liquid cooler passes back to the suction header for the high-pressure cylinder. This is illustrated in Fig. 1.

The Third Installation, Cleveland

The third installation is located in the Ninth Street Terminal Warehouse, Cleveland, Ohio, where two electrically-driven machines are installed. Each develops 75 tons of refrigeration at 0 lb. suction pressure. The low-pressure cylinders are each 17 x 32 in. and the high-pressure cylinders 12 x 32 in. The compressors are driven with silent chains by electric motors. There are sixteen coils of double-pipe-type ammonia condensers, 12 pipes high and 20 ft. 6½ in. long over-all, made of 1¼-in. and 2-in. pipe. There are also four coils, same dimensions as condensers, for warming the brine when defrosting of cold-storage coils is necessary. Whenever the coils are being defrosted, the four coils act as ammonia condensers. There is a small triplex pump for circulating the warm brine through a riser, with outlets on the different floors for hose connection. There is also a suction riser with hose connections conveniently located on the different floors. The room coils have connections extended into the corridor, also arranged for hose connections. By connecting with hose, any particular coil can be defrosted. There are two triplex pumps, each 9 x 12 in., one being a spare unit, for circulating cold brine.

Two vertical shell and coil brine coolers of standard construction are provided, each with shell 39 in. diameter and 12 ft. high. The compressors are driven by 200-hp. 230-volt compound-wound motors, operating at 400 r.p.m. There is installed in the brine system a 6-in. venturi brine meter, with monometer readings indicating the pounds of brine circulated. Thermometer wells are distributed throughout the system, at points where temperatures having an important bearing on the proper operation of the equipment can be observed.

The plant was started Nov. 23, 1917, and a few days after the first start the observations shown in Table I were made, one machine being in operation.

While these observations were being recorded, indicator

*Read before the Milwaukee Meeting, American Society of Refrigerating Engineers.

diagrams were taken at each end of both cylinders at the same instant. A sample set of these is shown in Fig. 2. The revolutions of the compressor were recorded on a revolution counter and were practically constant, the average for the six hours being 71.7 r.p.m. The diagrams were integrated and the average indicated horsepower for the low-pressure cylinder was 54, while the high-pressure cylinder showed 85, making an average total of 139 i.h.p.

It is interesting to analyze some of the temperature readings, such as those for the compressor discharge, liquid cooler, etc. The average suction pressure for the low-pressure cylinder was 0.935 lb., while the average temperature was —11.85 deg. F. This temperature agreed closely with the outgoing brine temperature and did not follow the temperature changes due to differences in the suction pressure. This simply means that the degree of superheat will depend upon the temperature of the brine circulated.

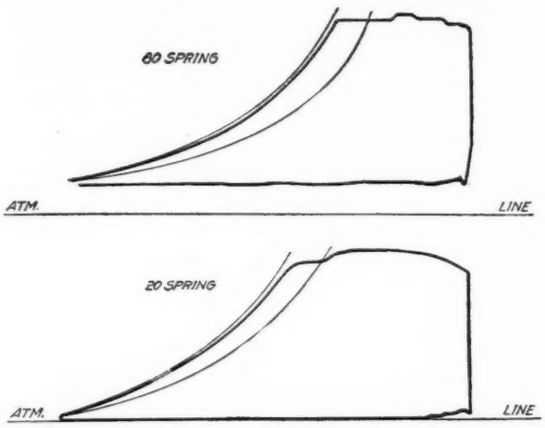


FIG. 2. UPPER DIAGRAM FROM HIGH-PRESSURE CYLINDER, CRANK END; LOWER DIAGRAM FROM LOW-PRESSURE CYLINDER, CRANK END

The discharge temperature for the low-pressure cylinder averaged 123.3 deg. F. The gas entering the intermediate-pressure drum before referred to was cooled to the average temperature of 15.19 deg. F., at which temperature it entered the high-pressure cylinder. The average pressure on the intermediate drum was 28.4 lb. and the temperature of saturated gas corresponding to this pressure is 15.5 deg. F. This indicates that the gas entered the high-pressure cylinder in a saturated condition, which is important and shows the efficiency of the method employed for removing the superheat due to compression in the low-pressure cylinder. Calculations for extreme hot weather conditions, where 80 deg. F. cooling water is available and an intermediate pressure of 50 lb., gage, is maintained, show a net reduction in the volume of vapor handled by the high-pressure cylinder of about 15 per cent. and a corresponding reduction in the horsepower for the high-pressure cylinder. The vapor from liquid required to do this cooling must be added to the reduced volume obtained by removal of the superheat.

The temperature of the discharge gas from the high-pressure cylinder averaged 182.6 deg. F., about what would be expected from compressing saturated gas of 28 lb. pressure to a condenser pressure of 147 lb. It might be well to add that with a simple compressor, operating at a suction pressure of less than one pound and a discharge pressure of 147 lb., a higher discharge temperature by about 100 deg. F. would be expected. The cool compressor operation is one of the distinct advantages of this two-stage compression system.

The temperature of the liquid ammonia was reduced to an average of 18.46 deg. F. from 66.05 deg. F., the cooling being done before the liquid passed to the brine cooler. The gas from the liquid cooler passed directly to the intermediate suction drum, where the average pressure was 28.4 lb. The liquid was cooled within about three degrees of the temperature corresponding to saturated vapor at the intermediate pressure.

The specific gravity of the brine circulated was 1.22. The average refrigeration tonnage produced for the six hours' run was

$$\frac{142{,}000 \times 98 \times 0.735}{12{,}000} = 85.4$$

During this time, and as previously given, the indicated horsepower for the compressor was 139, or 1.626 i.h.p. per ton. A standard simple compressor operating under the same conditions would have required 1.875 i.h.p. This indicates a saving of 15.5 per cent.

A wattmeter inserted in the electric circuit for the compressor showed an average of 139.5 kw. per hour. This would reduce to 187.4 hp. The motor operating at three-quarter to full load had an efficiency of 91 per cent., and, taking the chain drive as having an efficiency of 95 per cent., we would have 161.6 hp. at the compressor wheel. A standard compressor would have required 178 hp. Calculating the saving in this way, it would indicate a saving of 10 per cent. in the power delivered to the wheel. The total time the compressor ran, considering previous operation, would not exceed 10 hours. There seems to be considerable friction loss between the compressor-indicated horsepower and the electric readings, which will certainly be less as the chain is worn in and the bearings find a better seat.

From the practical standpoint there is every reason to believe that this system will accomplish exactly what it was laid out to perform and have the advantages of smaller dimensions in the cylinders on account of higher volumetric efficiency, less power required, reduction in ammonia losses due to decomposition and cooling of the liquid ammonia at low suction pressure with the intermediate pressure, thus doing the work more economically.

OBSERVATIONS TAKEN OF THE THIRD INSTALLATION, NINTH STREET TERMINAL WAREHOUSE, CLEVELAND, OHIO

Time	7:30	8	8:30	9	9:30	10	10:30	11	11:30	12	12:30	1	1:30	Average
R.P.M. compressor	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	71.70
Temp. of disch, L. P. cylinder, deg F.	119.5	122.5	125	123	120	120	124	122	120	119	118	119	125	121.30
Temp. of suct. L. P cylinder deg F.	+1.5	—4	—6.5	—8.5	—10	—12	—13	—15	—16	—16	—17	—18.5	—19	—11.84
Temp. of disch. hp. cylinder, deg. F.	160	173	176	189	189	200	160	169	182	198	206	180	205	182.6
Temp. of suct. hp. cylinder, deg. F.	15	14.5	14	13.5	13.75	12.75	17	16	15	11	20.5	14.5	20	15.19
Suct. pressure, lb. gage.	1.47	1.47	1.35	.98	1.10	.61	1.35	1.47	.98	0	.49	.49	.37	.93
Interm. press., lb. gage	29	29	28.2	27.4	27.9	26.6	32	30.5	29	25.4	26.4	28.4	26.6	28.40
Disch. pressure, lb. gage	140	142	144	145	147	148	152	150	150	146	147	147	148	146.61
R.P.M. brine pump	27	27	27	27	27.5	27	27	27.5	27	27	27	27	27	27.07
Temp. of water inlet, deg. F.	60	62	63	64	65	65.5	65	65.5	66.5	66	65	67	70	65.04
Temp of water outlet, deg F.	79	80	80	80	80.5	80.7	84	81.5	82	80	80	81	82	80.83
Temp of liquid amm. to cooler, deg F.	63	63	63.5	64	65	66.5	67.2	69	68.5	67	66	68	69	66.05
Temp. of liquid from cooler, deg. F.	19.5	19	18.5	17.7	18	17	22	20.5	19	15	18	19	17	18.46
Temp brine inlet, deg. F.	+4.4	+2.9	+0.9	—0.85	—2.6	—3.6	—4.35	—5.60	—6.6	—7.35	—8.6	—8.35	—8.6	.....
Temp brine outlet, deg. F.	—5.5	—7.5	—9	—11	—11.75	—13.25	—14.75	—15.75	—16.5	—16.75	—18	—18	—18.5	.....
Range, deg. F.	9.9	10.4	8.9	10.15	8.65	9.65	10.4	10.15	9.9	9.4	9.4	9.65	9.9	9.80
Thousand lb. per hour	141	142	143	142.5	145	143	142.5	144	142.5	142.5	142	142	142	142.3

Generation of Heat from Bituminous Coal and Its Absorption by the Boiler*

By HENRY MISOSTOW

How best results may be obtained from bituminous coal. Boiler and grate efficiencies and charts showing heat distribution in various types of boiler.

UPON subjecting bituminous coal to the furnace heat, moisture is first liberated and the dry coal remaining proceeds to break up under the action of the heat. The hydrocarbons forming the volatile part of the coal are driven off. The greater the carbon content of the volatile the greater the difficulty in burning it. This introduces the time element required for combustion as well as the necessity for artificially breaking up the liquid globules formed by hydrocarbons during the process of distillation.

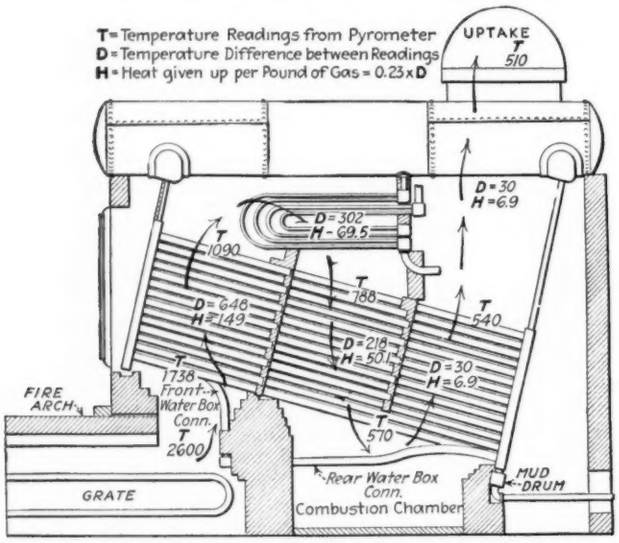


FIG. 1. HEAT DISTRIBUTION IN VERTICALLY-BAFFLED WATER-TUBE BOILER

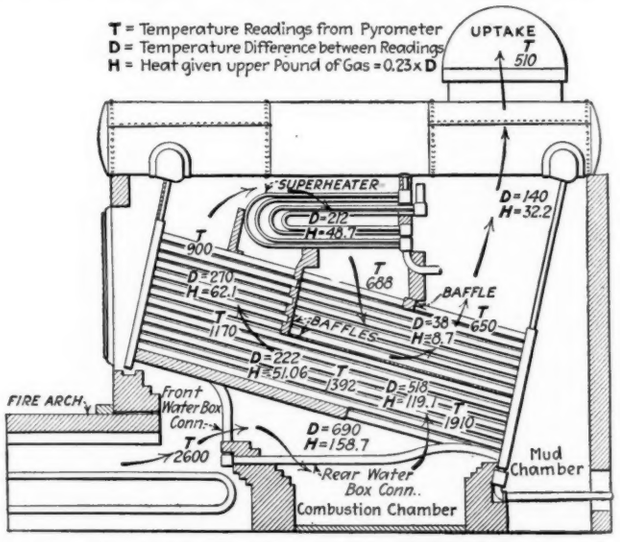


FIG. 2. HEAT DISTRIBUTION IN HORZONTALLY-BAFFLED WATER-TUBE BOILER

To obtain the best commercial combustion of bituminous coal requires a low distillation temperature, thorough mixture of the combustibles and oxygen, and rapid preparation of the combustible hydrocarbons for burning.

In practical work the results obtained depend upon the load, the furnace, the chimney and the fireman. With a good fireman and a bad combination of other conditions, it is possible to obtain fairly good results, but with a poor fireman, no matter how favorable other conditions may be, the results will gradually gravitate to the fireman's standard. Therefore the fireman is the most important factor in heat generation.

In burning coal the principal losses are droppage of fuel through the grate and the loss caused by incomplete combustion. The former can be detected by coke in the ashpit and the second by dense smoke. Incomplete combustion to a wasteful degree is indicated by smoke of greater density than No. 2.

Efficiency of heat transmission is determined by the ratio of heat transmitted to the total heat generated. In a study of heat absorption it is important to distinguish between the true boiler efficiency and the apparent efficiency. The total amount of heat indicated from gas analysis is not all taken up by the water in the boiler. Part of it is used to raise the temperature of the air passing through the setting into the gas passages, and part is used to provide for radiation from the setting and the boiler. Proper procedure is to determine the ratio between the apparent efficiency determined by tests and the efficiency indicated by an analysis of the flue gases. Once this ratio has been found it may be used as a constant by which to multiply the test efficiency to obtain the true efficiency. To illustrate, take an example from practice, where the indicated over-all efficiency was 79.27 per cent. and the apparent efficiency as determined by tests was 62.5 per cent. The ratio or constant in this case would be $62.5 \div 79.27 = 0.79$. Once this constant has been determined, it would be accurate enough for all practical purposes to use it as a multiplier of the apparent efficiency to obtain the true boiler efficiency.

A series of diagrams was shown indicating the heat-absorbing capacities of the various sections of different types of boiler. The charts showed the drop in temperature through the different sections and the amount of heat absorbed. Fig. 1, for example, is a sectional view through a vertically baffled three-pass water-tube boiler. The furnace temperature is 2600 deg. F. and the flue-gas temperature at the uptake 510 deg. F., the difference being 2090 deg., representing a heat absorption of 481 B.t.u. per pound of gas.

Temperature readings from the same type of boiler horizontally baffled are given in Fig. 2. In both cases the furnace temperature at the bridge-wall and the temperature of the gases at the uptake are the same. In the case of the vertically baffled boiler the gases leave the heating surface at 540 deg. F., and in the horizontally baffled boiler at 650 deg. F., a difference of 110 deg. The larger drop of temperature between the heating surface and the uptake in the horizontally baffled boiler was probably due to excessive air infiltration through the setting at this point. In the vertically baffled boiler it would be reasonable to suppose that infiltration at some other point reduced the gas temperature before the gases passed the tube surface. For practical purposes, if baffles are so distributed as to bring the gas into intimate contact with the heating surface, one type of boiler is as good as any other.

Heat distribution in a return-tubular boiler equipped with an ordinary hand-fired furnace is shown in Fig. 3. Here the fire temperature is 1513 deg. F. At the tube

*Abstract of paper read before the National Association of Stationary Engineers, Sept. 12, Cincinnati.

entrance the temperature is 992 deg., at the front of boiler 502 deg., and at the uptake, 445 deg. At the furnace one pound of the gases of combustion contains 348 B.t.u., and of this 232.5 B.t.u. were absorbed by the boiler. A striking feature is that 15 per cent. of the heating surface, the shell of the boiler, absorbed 119.8 B.t.u. and that the tubes, making up 85 per cent. of the heating surface, absorbed 112.7 B.t.u., or less than one-half of the total absorption.

In water-tube boilers there is also a marked difference in the activity of the heating surface. Reference to Fig. 1 will show that the tubes in the first pass of the vertically baffled boiler absorbed 149 B.t.u. from a pound of gas as compared to 6.9 B.t.u. for the third pass. In the latter the heating surface is about 85 per cent. of that contained in the first pass. If the third pass were as large and the 15 per cent. additional space absorbed heat at the same rate, the absorption in the third pass would have been 8.12 B.t.u. This means that one square foot of heating surface in the first pass is worth more than 18 sq.ft. in the last pass.

Efficiency of the grate may be determined by dividing the heat developed by the total heat in the coal. In the case of the chain grate there was 16.6 lb. of gas per pound

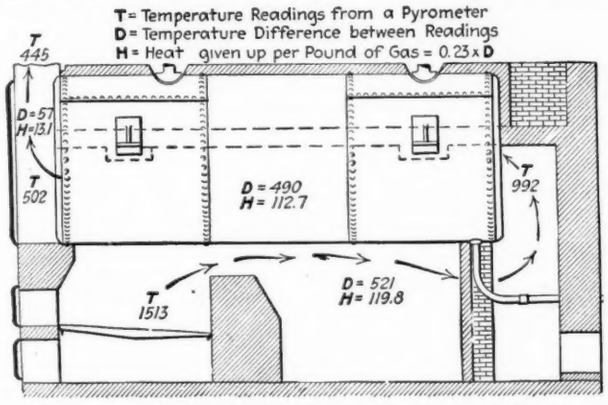

T = Temperature Readings from a Pyrometer
D = Temperature Difference between Readings
H = Heat given up per Pound of Gas = 0.23 x D
T 445
D=57 H=13.1
T 502
D=490 H=112.7
T 992
D=521 H=119.8
T 1513

FIG. 3. HEAT ABSORPTION IN RETURN-TUBULAR BOILER

of coal, and each pound of gas showed 598 B.t.u., giving 9926.8 B.t.u. as the total heat developed per pound of coal. By analysis the coal contained 10,030 B.t.u. per pound, so that the efficiency of the grate is $9926.8 \div 10{,}030 = 98.97$ per cent., which includes loss by droppage and incomplete combustion.

In the hand-fired furnace there was 35.69 lb. of gas per pound of coal and the coal as fired contained 12,843 B.t.u. The heat developed amounted to 12,420.12 B.t.u., so that the efficiency of the grate is 96.7 per cent.

In the discussion following the reading of the paper it was pointed out that the quantities of air for the hand-fired furnace and the chain grate were actual figures taken from specific plants and did not in any way indicate the relative efficiency of the two types of furnace. The discussion for the most part turned to grate surface, flue-gas temperatures, proper gas areas and specific directions for small plants where few instruments were available.

Effect of Salt on Reinforced Concrete

It has frequently been recommended that salt be placed in the water used to mix concrete in freezing weather, in order to decrease the liability of the concrete freezing while setting and hardening. A writer in *Concrete*, who was an observer for a period of 12 years of the effect of salt on reinforced concrete in a warm climate, concludes that salt should never be used in the construction noted. While the observations recorded were made on reinforced concrete in the Hawaiian Islands, where there is a warm, humid climate, still the failures of the structures were so serious and occurred within such a comparatively few years after construction that the use of salt with reinforced concrete is questionable practice in any section.

A case was cited where four years from the time of completion, cracks were observed in a reinforced-concrete structure, with rust discoloration. There was evidence of internal stress which produced a bulging of the surface—the action on the concrete created by the corroding steel. It appeared that there was no protection to the steel by concrete where salt water was used in the mixing. While in the writer's opinion the action on the reinforcing was many times greater in a warm climate than in a cold one, nevertheless all engineers might well consider the possible danger to reinforced structures from the use of salt in the mixing water. In observing structures that showed failure on the Islands, every one of them was exposed to salt influence, in many cases a small amount, but nevertheless disintegration had been abnormally fast. The structures in question had either been built under his own observation or he had carefully investigated the specifications and methods of construction.

Meeting of Refrigerating Engineers

The fourteenth annual meeting of the American Society of Refrigerating Engineers was held in the Engineering Societies Building, New York City, Dec. 2, 3 and 4, simultaneously with the yearly meeting of the American Society of Mechanical Engineers. The attendance was, as usual, pleasingly large.

A business session began the yearly meeting at which President Ezra Frick, of Waynesboro, Penn., made his address. The following papers and discussions were presented: "Ice-Plant Investments," by George E. Wells, St. Louis; "The Household Refrigerating Machine," by John E. Starr, New York City; Discussion on Refrigeration After the War; "Vapor Phase of Ethyl Ether," by Frederick G. Keyes and William Felsing, Massachusetts Institute of Technology; "Principles and Practices in Fusion Welding," by S. W. Miller, Rochester, N. Y.; "What Becomes of the Ammonia in Refrigerating Systems?" by George L. Reuschline, Philadelphia, Penn.; "Developments in the Ammonia Industry," by Dr. H. Dannenbaum, Philadelphia; Discussion on the Advantages of Ammonia Purifiers; "Flywheel as an Element in Synchronous Motor Drive," by F. L. Fairbanks, Boston; "Refrigeration in Relation to Air Conditioning in War Industries," by J. I. Lyle, New York City; Discussion on High-Speed Compressor Valves; "Electrically Driven Ice-Manufacturing Plants," by Charles R. Neeson, New York City; "The Carbonic Anhydride Refrigerating Machine," by Peter Neff, Canton, Ohio.

At a joint session with the American Society of Mechanical Engineers the following papers were presented: "Development of a Standard Refrgerating Car," by Dr. Mary E. Pennington, Food Research Laboratory, U. S. Department of Agriculture; "Refrigerating Plant Efficiency," by Victor J. Azbe, St. Louis. David Moffat Myers, Advisory Engineer, U. S. Fuel Administration, delivered an address.

Unfortunately, time did not permit of anywhere near the discussion that three of the paper warranted; namely, those of Mr. Fairbanks, Mr. Neeson and Mr. Azbe.

The annual dinner was held at the Hotel Astor, Tuesday evening.

George E. Wells, chief mechanical engineer, Anheuser-Busch Brewing Association, St. Louis, was elected president; F. E. Matthews, first vice president, and Prof. Edward F. Miller, Massachusetts Institute of Technology, second vice president. George A. Horne was again made treasurer.

Papers of interest to *Power* readers will be published as soon as they are available.

The cost of membership is but a dollar—a trifle in comparison to the sacrifices of those whom it will benefit. It is small, but it looms large when multiplied by one hundred millions of thankful and generous people. It will be used for the education and training in useful pursuits of those who have been crippled and disabled. Such is the work in which we are invited to share.

Annual Meeting of the American Society of Mechanical Engineers

CONTINUING the report begun in last week's issue, the Thursday, Dec. 5, morning session and the afternoon session in the auditorium were devoted to the consideration of "Engineering of Man Power." In the morning the following papers were presented: "The Engineer in Foreign Service," by Dr. L. S. Rowe, Assistant Secretary of the Treasury; "Industrial Organization as It Affects Executive and Workers," by C. E. Knoeppel; "Standardization and Administration of Wages," by Earl Dean Howard and Henry P. Kendall; "Nonfinancial Incentives," by R. B. Wolf. At the afternoon session in the auditorium: "The Evolution of the Organization of the United States Shipping Board, Emergency Fleet Corporation," by Charles Piez; "Employment of Labor," by Dudley R. Kennedy; "Labor Dilution as a National Necessity," by Frederick A. Waldron; "Intensive Training," by C. R. Dooley.

Charles E. Knoeppel, discussing his paper, said that the problem of the cost of living might be settled in two ways—there must be more producers or there must be a greater amount supplied by those now producing. The former solution is practicable if labor is allowed shorter hours, better conditions and a remuneration that will attract workers. The second can be employed by eliminating waste, standardizing conditions, setting fair tasks and allowing men to earn an amount that will compensate them for their skill and coöperation.

Nonfinancial Incentives

The paper by Robert B. Wolf on "Nonfinancial Incentives" brought out a great variety of discussion, which was continued in the afternoon session. The author contends that creative work by the workmen in the industries is not only possible, but with it there can be introduced a personal interest in the work beneficial alike to the employee and employer. Accounts were given of instances where this has been accomplished, through supplying foremen and workmen with information upon costs, methods of operation, possibilities in the direction of economy and efficiency, etc. Progress records are also furnished so that the employee will know from day to day how he is improving in the mastery of the process upon which he is engaged. Freedom to express one's individuality in constructive work, properly restrained by law, is considered by the author to be essential.

W. N. Polakov contended for the financial incentive or bonus, as did several others, but Mr. Wolf explained that his suggestion did not in any way oppose or displace the financial incentive but rather supplemented it.

Charles Piez, vice president of the United States Shipping Board, Emergency Fleet Corporation, gave in detail as the title of his paper indicates "The Evolution of the Organization of the United States Shipping Board, Emergency Fleet Corporation."

Employment of Labor

Dudley R. Kennedy, who is employment manager of the American International Shipbuilding Corporation, said the human-engineering phase of the country's industrial development had generally been overlooked. He said:

> We are now entering upon the war after the war and glibly discuss the social revolutions growing out of events in Europe, but many people do not seem to see that we are going through a momentous social revolution here and now. We hardly know what competition means; we will learn it within a few years. Permit me to prophesy that the executive of the next decade will be the man who best knows men. He will be an organizer, a handler of men as individuals, a handler of men in the mass, a leader, not a driver, a very human man. The science of human engineering is here to stay. The study of human characteristics is the most enduring, as well as the most fascinating, in the world, and still the most complex.

Frederick A. Waldron, in his paper on labor dilution, proposed the standardization of engineering products, the coöperative effort of legislators and engineers, the education of the public to a mental attitude of basic economy and a redistribution of occupations according to adaptability, as steps contributing directly or indirectly to the elimination of useless and unnecessary labor. Among other things, he said:

> Broadly speaking, labor dilution should consist not only in the functionalizing of the work of the skilled man with that of the less skilled man, but it is equally important to eliminate useless and unnecessary labor which, at the present time, is deemed necessary due to the mental attitude and the habits formed in years of development and peace. It would seem, therefore, that the problem of labor dilution can best be approached by classifying into the following program: (1) Standardization (indirect)—a. Legislative; b. Business and Financial; c. Transportation; d. Mining and Agricultural; and e. Manufacturing Methods. (2) Coöperation (indirect)—a. Legislative Methods; b. Capital and Labor; c. Engineering Methods. (3) Elimination (direct)—a. Nonessential Statistical Work and Data; b. Nonessential Office Work; c. Nonessential Administrative; d. Sales and Advertising Work; and e. the Idle Citizen or Loafer. (4) Education (direct)—a. Of the Legislator; b. the Business Man; c. the Engineer; d. the Executives, and e. the Laborer. (5) Occupation (direct)—a. Analysis; b. Distribution; c. Localization; d. Compensation.
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> It is "a condition and not a theory" that confronts us. If it is expected to keep in circulation the currency of the world at the present rate, it is necessary that public improvements, manufactories, agricultural and mining interests should continue at a rate commensurate with the present circulation of money. This means a gradual readjustment, and in order to be prepared for this readjustment, the problem should be looked squarely in the face and the way paved by which such readjustment can be made with the least possible disturbance. This can be done only by careful planning and action on the part of the country's greatest men in preparing to meet the problem of labor dilution in a broad way.

Mr. Dooley's Paper on Intensive Training

C. R. Dooley, Educational Director in Vocational Instruction, Committee on Education and Special Training for the War Department, in his paper "Intensive Training" told of the conditions in regard to tradesmen in the army. The run of the draft supplied just about one-half the required number of specialists and the Committee on Education and Special Training was looked to for the rest.

> This committee was appointed in February, 1918, with instructions to supply after two months each of intensive training a total of 90,000 men by Nov. 15. We all agreed that it could not be done, but had to be done and that was sufficient. The production chart was eagerly watched day by day until the danger line was passed and now we are closing up with a total of nearly 100,000 men trained in some thirty different trades. As an example of difficulties and accomplishments the Dickinson High School, Jersey City, positively had the least desirable detachment of men sent by the various draft boards to any school in the second district, and I am inclined to believe to any school in the country. Over 60 per cent. came from the lower East Side of New York—sweatshop workers, garment workers, toughs, gunmen, men from the docks, teamsters and every kind except men from the mechanical trades; men who had never been in an industrial shop; never handled a shop tool nor even a footrule and who seemed hopeless for training.
>
> They were assigned to classes and our job was started. In a few days there was a remarkable change. An able commanding officer and his lieutenants took them in hand. Owing to this admirable military discipline and the efficient shop instruction some 360 "fighting mechanics" were delivered to the army. There was one group of 26 blacksmiths, not one of whom had grasped a blacksmith's hammer or struck a piece of iron while it was hot before coming to the school; and at the end of six weeks nearly every one of them had accomplished more and better work than has been done in the regular course of forging at the school in less than a year's time. We were proud of these men when they left after the eight weeks of training, these men who had acquired the ability to do a real job and who also were

trained soldiers. One must live through an experience of this kind, in order to realize the remarkable, almost miraculous change that can be effected in men through this combined military and vocational training.

Among other things that have been shown by the war to be advantageous is that type of efficiency which reckons on the personal originality of each man rather than on the completeness of the detail of his instructions, of a type of training that is flexible and elastic rather than rigid and exact in all predetermination. The war has been won through inspiring leadership that somehow seemed to spring from the atmosphere rather than through autocratic force. And so with the soldier-mechanic, much faith is placed in his ability to meet successfully new situations if only we can give him a correct understanding of the simple fundamentals of his trade and stimulate his constructive imagination.

The war is over. Thousands of men will return to industry with keen, alert minds, disciplined to act promptly and thoroughly as members of a team rather than as individuals. Many will not be highly skilled in civil occupations and will have to be trained in special work, but they will learn quickly and will advance rapidly because of their military experience.

Doings of the Textile Session

The Textile Session, under the auspices of the subcommittee on textiles, was held at 2 p.m. and was well attended. E. D. Walen read an interesting paper on "Properties of Airplane Fabrics," in which he explained the apparatus and methods used to determine the physical characteristics of cotton fabrics as intended for airplane coverings. The results of these tests, which were made in much the same manner as for other structural materials, rendered possible the development of a suitable cotton fabric in place of the linen covering that had previously been used but that was not available because of the greatly increased demand. The discussion of the paper by W. F. Uhl on "Industrial Power Problems" led inevitably to the question of isolated plant versus central station as a source of power. Mr. Uhl emphasized the point that in a great many industries the cost of power was of minor importance when compared to reliability. The discussion, however, indicated that in many industries there was need of considerable quantities of steam for various manufacturing processes and that in such cases the isolated plant generating its own power and using all its exhaust steam would be found to be a satisfactory solution of the power problem. Incidentally, Mr. Uhl showed that it was not safe to reckon power on the basis of a certain number of dollars per horsepower per year, because so many factors enter into the cost of power. Other papers considered at this session were "Daylight vs. Sunlight in Sawtooth Roof Construction," by W. S. Brown, and "Factory Stairs and Stairways," by G. L. H. Arnold.

Thursday Afternoon General Session

The General Session, which also began at 2 p.m., was given over to the consideration of two papers, both of which evoked much discussion. The first was by F. A. Halsey on "The Weights and Measures of Latin America." In it Mr. Halsey gives a summary of the answers to about 500 copies of a questionnaire sent into South and Central America and the West Indies, relating to the extent of use of the metric system. According to the summary, the claim that Latin America is metric is exploded; instead, a confusion of metric and nonmetric weights and measures is in use. A motion was made suggesting that the Council investigate the proposal of a meter of 40 in. with a view to its adoption as a standard. After much debate, the motion was laid on the table. The general impression was that this is no time to change our basis of weights and measures. The second paper, by H. L. Gantt, dealt with "Efficiency and Democracy." In it Mr. Gantt gave an explanation of the state of disrepute into which the term "efficiency" has fallen. He attributes it to the fact "that in the past efficiency has been measured by the dollars acquired rather than by the goods produced."

Thursday evening was "Army Night," with a lecture by Col. James B. Dillard, Engineering Division, Ordnance Department, on "Railway Artillery," with slides and motion pictures. Following the lecture there was a reunion and dance with refreshments.

On Friday morning the Power-Plant Session and the General Session were merged and held in the auditorium. Most of the papers of this session were read by title only because of the lack of time, and their discussion was limited for the same reason. They were: "The Conservation of Heat Losses from Pipes and Boilers," by Glen D. Bagley; "Chemical and Physical Control of Boiler Operation and the Application of Simple Formulas for Estimating the Heat Loss Items, Etc.," by E. A. Uehling; "The Cooling Losses in Combustion Engines as Affecting Design," by C. A. Norman (contributed by subcommittee on Gas Power); "Discussion of Certain Problems in Regard to Marine Diesel Oil Engines," by J. W. Anderson (contributed by Subcommittee on Gas Power); "Valves and Fittings for High Hydraulic Pressures," by W. W. Gaylord; "The Relative Corrosion of Alloys," by R. B. Fehr; "The Relative Corrosion of Cast-Iron, Wrought-Iron and Steel Pipe in House-Drainage Systems," by William P. Gerhard; "Determination of Stresses in Wire Rope as Applied to Modern Engineering Problems," by J. F. Howe; "Mechanical Features of the Vertical Lift Bridge," by Horatio P. Van Cleve.

Valves and Fittings for High Hydraulic Pressure

The paper by Mr. Gaylord suggested a method of figuring the strength of hydraulic pipe, valves and fittings and shows it applied to a system to use 7500 lb. per sq.in. working pressure. The joints, valves and fittings used on the system are described, as well as those that failed in operation. In reply to a question as to whether he had had any experience with soft metal packings Mr. Gaylord said that he had not. Red fiber gaskets and cup leather packings were used in the valves described. The second paper of the session was read by the author, Glen D. Bagley. It presented the results of a series of experiments made at the Mellon Institute of Industrial Research on 85 per cent. magnesia coverings. The first step in the investigation was to determine the loss of heat from bare pipe, which is commonly stated to be about 3 B.t.u. per hour per square foot per degree difference of temperature. It was found that the size of the pipe and the temperature difference affect the value of the loss and that it runs from 50 per cent. below 3 B.t.u. to considerably above it. The apparatus used for the tests consisted of three sections of 3-in. pipe in one length, the middle section being 3 ft. long and each end section 1½ ft. long. The sections were connected by heat-insulating disks of asbestos board and the heat was produced by electric heaters inside the pipes. The tests were made on five different makes of magnesia, of 1-in., 2-in. and 3-in. thicknesses. The decrease of heat loss by increase of thickness from 1 in. to 2 in. is from 2½ to 3 times that between 2 in. and 3 in. Another interesting fact shown by the experiments and also brought out by others in the discussion was that old magnesia coverings in good condition had somewhat lower heat losses than new coverings of equal thickness. On the other hand, oil-saturated coverings were permanently damaged and were not nearly so effective as new ones. This paper will be abstracted and published in *Power* in the near future. One speaker who discussed it regretted that no experiments had yet been made to find the effect of velocity of steam flow on the rate of transmission of heat from a steam pipe.

The Relative Corrosion of Alloys

In the absence of R. B. Fehr, his paper was presented by Dean R. L. Sackett. It points out the limitations of the various methods of expressing the results of corrosion tests and then proposes a new method, in which the results are expressed as the per cent. loss of unit volume for each unit of surface. The most important conclusion is that careful, refined laboratory tests involving a duration of several days to several weeks may serve as a satisfactory compromise between the one- or two-hour acceleration tests and the long-time service tests. E. A. Uehling in his paper outlined the two methods of determining boiler economy: The mechanical method, based on heat utilized, and the chemical method, based on heat wasted. He showed the advantages and disadvantages of each, concluding that no wholesale method is adequate. He insisted that every boiler must be treated individually and that adjustments

must be made continually to keep results right. W. N. Polakov in the discussion showed a number of slides to illustrate a method of boiler-efficiency control he had used with good results. The paper was further discussed by Dr. D. S. Jacobus and Victor J. Azbe.

The meeting of the Council for the installation of the newly elected officers and other business was held at 2 p.m. The regular college reunion Friday evening was the closing event.

The attendance in members and guests, while not a record, was within a hundred or so of it. There were 1040 members and nearly 700 guests registered. Several enjoyable excursion trips were provided for those who cared to go.

Abuses of Stokers*

By Micheal O'Leary

The Government questionnaire on power plants, after covering the equipment and its condition, takes up the matter of supervision, because the best apparatus and the highest grades of coal may be wastefully used and much waste ensue if the labor operating them and the supervision of the plant are incapable, lax or lacking.

Of late, one of the main points to be considered in improving the boiler room, since new apparatus may not be obtainable, as brought out by the various fuel conservation meetings throughout the country, is the exercise of greater care and superior supervision. The more conversant one becomes with boiler rooms the more one wonders that a greater number of accidents do not happen, that more coal is not wasted, and that many plants are able to continue in existence, as is the case. In one large plant recently inspected were a number of 500-hp. boilers. The only instrument in the plant was a venturi water meter for measuring the makeup water. There were no draft gages, no steam-flow meters, no thermometers, CO_2 recorders nor any other instrument except a steam gage for each boiler.

The boilers all operated in parallel, each being equipped with mechanical stokers. Some of these stokers were chain grates, some underfeeds. Soon after the underfeeds went in, two furnaces were so equipped, and it was found that the brickwork would not stand up except for a very short time. Complaint was made that the setting was incorrect, the stokers were no good and would not be accepted until brick troubles were eliminated.

Investigation showed that the two underfeed stokers were operating between 200 and 300 per cent. rating and often higher. The chain-grate stokers with their natural draft had their speed, which means rate of fuel burning, controlled by the firemen; also their air supply. On the other hand, the underfeed stokers with their forced draft had both coal and air controlled automatically according to the steam pressure. Under these circumstances, when the steam pressure dropped as the load came on suddenly, the underfeed stokers attempted to pick up the load instantly and automatically, whereas the hand-controlled chain grates continued their rates of combustion until the fireman attended to them. The result was that the underfeeds did an excess of work, grabbing the load, thus eventually burning out the brickwork.

It might be mentioned that the use of steam-flow meters on the individual boilers, or at least on those equipped with underfeed stokers and forced draft, would have enabled individual boiler performance to be known and proportioned pro rata, instead of nothing being known about the plant. Weighing the coal to each stoker would also serve much the same purpose, while the use of draft gages would have helped considerably.

During the winter of last year I visited another plant containing 10 boilers of 500 hp. each, equipped with underfeed stokers. This plant was serving a load considerably in excess of its capacity, and boilers as well as generators were hard put to it to carry the load. The underfeed stokers were new, replacing another type now going out of use. With eight of the new stokers in use, word came that the stoker grates were burning out for no apparent reason, that something was wrong and that something had to be done to set things right. The plant was visited at a time when one stoker, the second one to require it, was having new dump plates installed to replace a set that had been burnt after only a short time in service.

In passing down the boiler aisle I immediately saw that the boilers were operating at about 150 to 200 per cent. rating. I also saw from the draft gages that some of the pressures under the fire were exceptionally high, suggesting excessively thick fires, insufficient stack-damper opening or similar operating condition. While waiting around the plant looking at the fuel beds, keeping tab on the draft under and over the fires, windbox pressures and position of breechings dampers, etc., the ashpits were also inspected. In looking into the fire and later up into one ashpit underneath the grate, the flame could be seen to be passing into the ashpit apparently as much as up through the boiler passes. A closer inspection through the ashpit showed that flame was playing continually around and underneath dump plates and grates. Opening the damper in the breeching resulted in instant cessation of the flame around and under the grate and dump plates, these flames passing over the normal path up toward the boiler tubes.

Draft gages were installed to indicate the draft under and over the fire, and the condition as found to exist rehearsed. It was shown the firemen that as the rates of combustion changed and as the blower speed increased and likewise amount of air being forced through the fire, the breechings damper was not opened sufficiently nor synchronously. The result was that the gases and heat from the fuel bed, instead of passing up through the boiler passes unhampered to the stack, found a duplicate path under the grates through the ashpit, doing damage and wasting fuel. This was the reason the grates and dump plates had burnt out, a cause directly due to carelessness on the part of the firemen and lax supervision of the worst sort. The situation ought to have been suspected by the engineer the first time it happened. The installation of draft gages would have prevented the occurrence, provided the men understood the significance of their indications.

*From *Electrical Review*.

Power as a Burden on Transportation

In the industries of the United States machine processes and large-scale operation are utilized to a greater degree than in any other part of the world, and mechanical appliances are used extensively in the domestic life of the country. As a consequence, special emphasis is placed on the use of power, and it is significant that the United States consumes nearly half of the world's output of coal and over half of the total production of petroleum, not to mention the use of water power, natural gas and minor sources of power.

This extraordinary consumption of power lays a heavy burden on transportation, because of the necessity of distributing the coal and the oil as well as hauling the raw materials and the finished products of the shops and factories; and since the industrial life of the nation is increasing by rapid strides, it becomes apparent that there must be some serious thought devoted to improving or relieving our systems of transportation.

A clear and comprehensive statement of the conditions existing at present, an analysis of the situation and suggestions for the solution of the problem are contained in a 50-page bulletin entitled "Power: Its Significance and Needs," which has recently been issued by the Smithsonian Institution. The authors are Chester G. Gilbert and Joseph E. Pogue, of the Division of Mineral Technology of the United States National Museum and the bulletin is one of a series dealing with the mineral industries of the United States. Its purpose is to outline the nature of the situation and suggest remedies therefor. The subject is handled in masterly fashion and no brief abstract can convey a correct idea of its scope. The following extracts, however, will serve to show the difficulties to be met and the manner in which the authors would overcome them.

American industrialism differs from the industrialism of other nations in two respects; it places unusual emphasis upon the employment of power and it couples an advanced industrial development, which means a high standard of

living with a vast expanse of territory. Each of these conditions imposes a special demand upon transportation, and the two combined have given rise to transportation difficulties that are threatening to throttle the economic life of the country.

The issue cannot be adequately met by furthering the development of the railways alone, for already this type of carrier has been pushed to such a point of overdevelopment as to constitute a critical weakness in the economic structure of the country. Hence the logical way to correct the transportation unfitness of this country is to attack the matter through improvement in power usage.

Three principles of transportation underlie industrial growth, and industrial activities in general conform to their prescriptions as a matter of course. These factors are represented in (1) the employment of suitable facilities for the task of transportation, (2) the advance elimination of superfluous weight and (3) the full utilization of the material transported. These conditions are seen to be the merest common sense; illustrations of conformity with them are on every hand; in the matter of power alone they have been utterly disregarded.

The righting of the power situation requires (1) the establishment of a comprehensive system of electric transmission lines to be administered as a common-carrier system like the railways. (2) The provision of such a system will necessitate the coördinated growth of central power stations in coal fields and at water-power sites, and in doing so will open to business enterprise a tremendous field of opportunity hitherto closed off from entry, and thus lead to the balanced development of the two major energy resources, coal and water power. (3) The principle of multiple production, recognized and incorporated in national policy, will supplement the additional service gained through the organized employment of the electrical principle; applied to the production of coal-generated electricity, and, through the medium of municipal public-utility plants, to the distributive employment of coal, this principle will effectively correlate the recovery of the commodity and energy values, so as ultimately to effect a full saving of the former and an increased gain of the latter, thus permitting a further relative diminution of the amount of fuel calling for transportation in bulky form. The first two points reduce themselves to a single issue, which is purely a business proposition to be handled by a business organization; the third item is more intangible and it is a matter of policy, which, therefore, cannot be delegated or otherwise handled in objective fashion.

The provision of a common-carrier system of transmission lines, in brief, is the key to the whole problem. Its establishment will remove the retarding influence of high interest rates and antagonistic misunderstanding that has blocked water-power development and will afford the point of departure from precedent in favor of coal-field generation of electricity.

Thus specific action in respect to establishing a common-carrier system adapted to the power needs of the country will not only go far toward solving the problem of transportation, but it will improve the fuel supply, correct the economic fallacy of drawing upon capital resources while neglectful of income, contribute to the recovery of the values now lost in the consumption of raw coal, lead to an adequate development of electrochemical activities, cut off a needless annual expenditure running well beyond the billion-dollar mark, and constitute a potent contribution in the direction of stimulating the upgrowth of a constructive economic policy of national scope attuned to the needs of modern industrial development. It is believed that these results would involve national economies, offsetting in large part the cost of the war.

Obituary

Edward Allen Wickes, president and a director of the Niagara Falls Power Co., Tonawanda Power Co., Cataract Power and Conduit Co., and a director of the Canada Southern Railway Co., and the Bridge and Railway Companies, died suddenly at his home, 420 Park Ave., New York City, on Dec. 6.

Franklin R. Moore, past supreme chief engineer of the American Order of Steam Engineers, died suddenly on Dec. 7, aged 57 years. He was a charter member of Southwark (Penn.) Council, No. 4, A. O. S. E.; a member of Potter Lodge F. and A. M. and also of the Vulcan Assembly. Mr. Moore has for many years been connected with the sales department of E. F. Houghton & Co., of Philadelphia. The funeral services took place on Wednesday afternoon, at his late home, 1333 Wolf St., Philadelphia. Interment at Woodlands Cemetery. Mr. Moore is survived by a widow and daughter.

Personals

Lewis H. Miller, formerly mechanical engineer with the Tennessee Coal, Iron and Railroad Co., is now designing engineer with the Babcock & Wilcox Co., Barberton, Ohio.

W. F. Keckeisen, formerly advertising manager of the International Filter Co., and previously associated with the Federal Sign Co., has joined the staff of Russell T. Gray, advertising engineer, Chicago.

Byron T. Motlinger, who has been making a creditable record as general superintendent of power of the Fort Dodge, Des Moines & Southern R. R., Boone, Iowa, announces that after Jan. 1, 1919, he will be associated with the Quaker City Rubber Co., of Philadelphia, as chief engineer and master mechanic.

J. O. Smith, who has been in Washington, D. C., as radio engineer in the Division of Military Aeronautics, has returned to New York City, and is now with the Wilson Welder and Metals Co., 2 Rector St., engaged in sales promotion and research work, in which his long experience in the technical publishing field will be valuable.

L. E. Schumacher, who for the last eight years has been chief inspector of the Westinghouse Electric and Manufacturing Co., at East Pittsburgh, Penn., has been promoted to works manager of the Krantz Manufacturing Co., of Brooklyn, N. Y., the latest subsidiary of the former company. Prior to his coming to the Westinghouse company in June, 1900, Mr. Schumacher was employed at the Niagara Falls Power Co., which at that time was the largest electric water-power installation in the world.

C. T. Henderson has resigned as chief engineer of the Submarine Boat Corp. and is now acting as chief engineer of the Hercules Engineering Corp. and president of the Electrolytic Engineering Corp., of New York. He was formerly general manager of the Niagara (N. Y.) Smelting Corp. and prior to that was with the Cutler-Hammer Co.

New Construction

PROPOSED WORK

Me., Bangor—A. B. Haskell Co., Church St., plans to build an 18 x 25 ft. boiler house in connection with its new 3-story factory.

Mass., Chatham—The Bureau of Yards & Docks, Navy Department, Washington, D. C., is receiving bids for the construction of a boiler house, heating and drainage system, pump house, etc. Estimated cost, $45,000. C. W. Parks, Chief. Noted Nov. 12.

Mass., Lawrence—The American Woolen Co. has awarded the contract for the construction of a 10-story, 165 x 170 ft. woolen mill to the E. W. Pitman Co., 703 Bay State Bldg. A vacuum heating and electric power system will be installed in same. Total estimated cost, $800,000.

Mass., North Truro—The East Harbor Fertilizer Co. plans to build a 1-story boiler house.

Mass., Shelburne Falls—The Mayhew Steel Products Co., 295 Broadway, New York City, N. Y., has awarded the contract for the construction of three 1-story factory buildings, to the Austin Co., 217 Broadway, New York City, N. Y. A steam heating system will be installed in same. Total estimated cost, $115,000.

Conn., Hartford—The Phoenix Mutual Insurance Co., 49 Pearl St., will install a steam heating system in the 6-story, 100 x 150 ft. office building which it plans to build. Total estimated cost, $500,000. B. Morris, 101 Park Ave., New York City, N. Y., Engr.

Conn., Hopewell—F. W. Mellor, Engr., will soon receive bids for the construction of a boiler house, wash house, round house, etc., here, for the New York, New Haven & Hartford R. R., Meadow St., New Haven. Address engineer in care of railroad. Estimated cost, $50,000.

Conn., Leesville (Moodus P. O.)—L. P. Perry, Engr., East Hampton, will soon receive bids for the construction of a 1-story power house on the Salmon River, here, for the Central Connecticut Power & Light Co., East Hampton. Estimated cost, $26,000. Noted Nov. 26.

Conn., New London—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for installing a high pressure air system in the Navy Yard here; Specification No. 3669.

N. Y., Binghamton—The Common Council plans to build a municipal lighting plant. Estimated cost between $10,000 and $15,000. T. H. Quinn, Chn.

N. Y., New York—The Cunard Steamship Co., 25 Broadway, will install a steam heating system in the 250 x 250 ft. office building which it plans to build. Total estimated cost, $4,000,000. B. Morris, 101 Park Ave., Arch.

N. Y., New York—Fred T. Ley, 19 West 44th St., will install a steam heating system in the 19 story, 100 x 200 ft. manufacturers' club building which it will build on 7th Ave., between 30th and 31st Sts. Total estimated cost, $1,500,000.

N. J., Milltown—The Elizabethtown Water Co., 68 Broad St., Elizabeth, plans to build a new pumping plant near Landing Bridge, to have a capacity of 20,000,000 gallons. Estimated cost, including equipment, $150,000. John W. Whelan, Secy.

Penn., Brockwayville—The Erie R. R., Church St., New York City, N. Y., plans to build an engine terminal building, including a power house, machine shop, etc. R. C. Falconer, 50 Church St., New York City, Ch. Engr.

Penn., Clifton Heights—The Knot Manufacturing Co. plans to build a 1-story, 60 x 80 ft. engine house. F. E. Hahn, 1112 Chestnut St., Philadelphia, Engr.

Penn., Philadelphia—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for installing mechanical stokers in the Navy Yard here; Specification No 3586.

Del., Wilmington—Jessup & Moore, Commercial Trust Bldg., Philadelphia, Penn., plans to build a 1-story addition to its boiler plant here. A. C. Wood, 1411 Walnut St., Philadelphia, Engr.

Md., Baltimore—The Water Department, City Hall, is in the market for a pump and turbo-generator, in connection with improvements which it plans to make to the water system. Total estimated cost, $100,000.

Fla., Jacksonville—The city plans to enlarge the power house. Warren Scott, Mayor.

Miss., Meridian—The Mississippi Fiber Co. is in the market for power plant machinery.

Ky., Louisville—Tuck & Co., 1443 West Main St., has awarded the contract for constructing an addition to its boiler house and remodeling factory, to Rommell Bros., 919 East Broadway. Estimated cost, $28,000.

Ohio, Ashtabula—The city plans to construct a lighting plant.

Ohio, Akron—B. F. Goodrich Co., Cherry and Canal St., plans to make improvements to its power plant, and will install boilers, electrical appliances, etc. Estimated cost, $750,000. Griggs & Meyers, 110 West 40th St., New York City, Engr.

Ohio, Napoleon—The Cleveland, Cincinnati, Chicago & St. Louis R. R. plans improvements here to include the construction of a power house, round house, etc. Total estimated cost, $80,000. C. A. Paquette, Ch. Engr.

Ill., Chicago—The American Car & Foundry, 2289 South Paulina St., has had plans prepared for the construction of a 1-story engine plant.

Ill., Chicago—The Baltimore & Ohio R. R., Grand Central Station, plans to build a boiler house on Burley Ave.

Wis., Ashland—The Davis Mill Co. plans to build an addition to its power house and will install a 100 h.p. engine.

Wis., Fall River—The Fall River Canning Co. plans to build a boiler room. F. E. Hubburt, Mgr.

Wis., Janesville— The Common Council plans to enlarge the municipal hydro-electric generating plant and the steam generating system. C. V. Kerch, City Engr. J. C. Jacobsen, 1135 First National Soo Bldg., Minneapolis, Minn., Engr.

Wis., Oconto—The Holt Hardwood Co. plans to extend and improve its steam generating plant.

Iowa, Buck Grove—The city plans to call bond election for completing electric-light plant.

Iowa, Sioux City—Gardner & Linberg, Engr., 140 South Dearborn St., Chicago, Ill., will soon receive bids for the installation of a heating system in connection with the packing plant which the Midland Packing Co., Union Stock Yards, plans to build. Total estimated cost, $1,000,000.

Minn., Hibbing—The Oliver Iron Mining Co., Wolvin Bldg., Duluth, has awarded the contract for the construction of a 3-story, 45 x 145 ft. hospital here, to Jacobson Bros., 410 Columbia Bldg., Duluth. A heating plant and vacuum ventilating system will be installed in same. Total estimated cost, $300,000.

Minn., Hibbing—The Oliver Iron Mining Co., Wolvin Bldg., Duluth, will install a steam heating plant in the 2-story, 106 x 125 ft., mercantile building which it will build here. Total estimated cost, $100,000. S. S. Rumsey, Wolvin Bldg., Duluth, Arch.

Minn., Minneapolis—The Clover Creamery Co., 420 20th Ave., will receive bids in the spring for the construction of a 2-story, 28 x 44 ft., power plant and milk receiving room. C. A. Berger, 811 Sykes Bldg., Engr.

Kan., Downs—The Mayor and City Council plan an election Dec. 17 to vote on a $40,000 bond issue for the construction of an electric light and power plant.

S. D., Sioux Falls—The city voted a $300,000 bond issue for the construction of an electric-light and power plant.

N. D., Ashley—The Ashley Electric Co. is in the market for a 200 hp. Corliss engine. S. P. Waage, Mgr.

Mo., Waverly—The Waverly Electric Co. is in the market for a duplicate generating unit for emergency purposes, a 20 kv.-a., 3-phase generator and a 25 hp. gas engine.

Okla., Ardmore—The Ardmore Street Railway Co. plans to build a power plant in connection with the construction of an electric railway. Address I. M. Putnam.

Colo., Hugo—C. C. Bogue has applied to the City Council for a franchise to build an electric-light plant here.

Idaho, Arco—The City Council plans to install machinery to improve the local power plant.

Ont., Brampton—The Hercules Rubber Co. is in the market for one 200-hp., 25 cycle, 550 or 220-volt motor; one 15-hp. motor and a number of 3 to 5 hp. motors.

Ont., Harrow—The Town Council plans to build a power plant and install an electric system. J. H. Madill, Clk.

Ont., Owen Sound—The Corbet Foundry & Machine Co., Ltd., is in the market for one 10 and one of 5-hp., 550-volt, 60-cycle, 3-phase, electric motors.

Ont., Sarnia—The City Council will install a motor-driven sludge pump in the water-works plant. Estimated cost, $10,000. H. F. Hall, Engr.

Ont., Toronto—The Auto Renovating Co., 1175 Bathurst St., is in the market for a 40-hp., 55-volt motor.

Ont., Toronto—H. J. Maughan, 382 Glenlake Ave., is in the market for a 2½-hp. gasoline engine.

Que., Montreal—The Shawinigan Water & Power Co., 83 Craig St., W., will rebuild its plant recently damaged by fire entailing a loss of $25,000.

CONTRACTS AWARDED

Mass., Chelsea—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the installation of a steam heating system here, to J. P. Dwyer Co., 183 Harrison St., Boston. Noted Nov. 19.

Mass., State Line—The New York, New Haven & Hartford R. R., New Haven, has awarded the contract for the construction of a boiler house, roundhouse, turntable building, etc., to the H. Wales Lines Co., Meriden. Total estimated cost, $80,000. Noted Dec. 3.

N. Y., Brooklyn—The State Hospital Commission, Capitol, Albany, has awarded the contract for the installation of a refrigerating plant in the Brooklyn State Hospital, to Karl Vesterdahl & Co., 90 West St., New York City.

N. Y., Sayville—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received lowest bid for the installation of a heating system in the Navy Yard here, from the Raisler Heating Co., 129 Amsterdam Ave., New York City. Estimated cost, $5300.

N. Y., Utica—The Utica Steam & Mohawk Valley Cotton Mills, 801 State St., has awarded the contract for the construction of an addition to its engine room, to Hopp & Down, 1022 Seymour Ave. Estimated cost, $15,000.

Penn., Nanticoke—The Liberty Throwing Co. has awarded the contract for the construction of a 1-story, 32 x 50 ft., boiler house on Church St., to A. M. Hilderbrand, 91 Wood St., Wilkes-Barre. Estimated cost, $8000. Noted Nov. 26.

Md., Baltimore—The Baltimore Co. Water & Electric Co., 100 West Fayette St., has awarded the contract for alterations to its boiler house, to the Price Construction Co., 210 Maryland Trust Bldg. Estimated cost, $4000.

Ohio, Lakewood—The Cleveland Welding & Manufacturing Co., 2129 West 117th St., Cleveland, has awarded the contract for the construction of a 1-story, 80 x 106 ft., electric power plant, to the Hunkin Conkey Construction Co., Century Bldg., Cleveland. Estimated cost, $50,000.

Ind., Indianapolis—The Indiana Medical University has awarded the contract for the construction of a 1-story, 40 x 40 ft., power house at 1080 West Michigan Ave., to the Bedford Stone & Construction Co., 810 Fletcher Savings & Trust Bldg. Estimated cost, $6000.

Ind., Indianapolis—The Van Camp Packing Co., 2000 South East St., has awarded the contract for the construction of a 1-story, engine and boiler room, to the Bedford Stone & Construction Co., Fletcher Savings & Trust Bldg. Estimated cost, $50,000.

Ill., Chicago—The Consumers Packing Co., 11 South La Salle St., has awarded the contract for the construction of a packing plant at 1400-1426 West 46th St., to the Salamon-Waterton Co., 343 South Dearborn St. Plans include the construction of power buildings with all the appurtenances, refrigerator, cold storage, etc. Total estimated cost, $500,000.

Ill., Chicago—The Herman Loesher Co., 2022-2024 Mandell St., has awarded the contract for the construction of a 1-story, 41 x 60 ft., boiler house, to C. Rasmussen, 154 West Randolph St. Estimated cost, $15,000.

Wis., Hartford—The Hartford Canning Co. will build a 40 x 40 ft. boiler house, cannery, etc. Total estimated cost, $45,000. Arthur Lau, Gen. Mgr.

Wis., Neenah—The Gilbert Paper Co. has awarded the contract for the construction of a 1-story, 97 x 100 ft., power house and stack, to C. R. Meyer & Sons Co., 50 State St., Oshkosh.

Ont., Hamilton—The Mercury Mills, Ltd., Cumberland Ave., has awarded the contract for the construction of a 1-story brick boiler house, to G. E. Gaylord, 54 Lamoreaux St. Estimated cost, $3000.

Ont., London—The Peerless Hosiery Co., Ltd., Adelaide St., has awarded the contract for the construction of a 1-story boiler house, to R. G. Wilson & Co., 193 College St. Estimated cost, $8000.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$6.55	$7.30	Broken	$7.80	$8.55
Buck.	5.10	5.90	Egg	7.70	8.45
Rice	4.65	5.10	Stove	7.95	8.70
Barley	4.15	4.30	Chestnut	8.05	8.80

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b. Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr Ago
Pea	$4.80	$3.40	$6.05	$4.30
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.50
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70	$3.25—3.40	
Mine-run	2.35—2.50	3.00—3.15	
Screenings	2.05—2.20	2.75—2.90	

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70
Climax seam near Maylene,			

St. Louis—Prices per net ton bituminous coal f.o.b. mine today as compared with a year ago are as follows:

	Williamson and Franklin Counties, Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.55@2.75	$2.40@2.70
Mine-run	2.35@2.50	2.20@2.30
Screenings	2.17@2.32	1.50@1.50

Williamson-Franklin rate to St. Louis is $1.10.

other rates p. 95.